INFORMATION

ON

COMMON OBJECTS.

me and colonial school society, Lo

INFORMATION

ON

COMMON OBJECTS

FOR THE USE OF

INFANT AND JUVENILE SCHOOLS,

AND

NURSERY GOVERNESSES.

LONDON:
ISHED FOR THE HOME AND COLONIAL INFANT SCHOOL SOCIETY, BY
DARTON AND CLARK,
HOLBORN HILL.

1845.

c

PREFACE.

The following work has been prepared at the request and under the superintendence of the Committee of the Home and Colonial Infant School Society.

The end proposed was the communication of such knowledge as would be desirable for a teacher to possess before giving a lesson on any common object, and only such facts have been stated as it is requisite they should know. It may not be out of place to guard teachers against the supposition that they are to bring before the children all the knowledge here communicated; the aim is rather to put them in possession of that confidence which is essential to the giving a really good lesson—the confidence that they are acquainted with their subject, and are prepared to satisfy the desire for information which an examination of any

of the objects may awaken in the minds of th
pupils.

The objects described are contained in a box arrang
for the use of schools according to instructions giv
by the Committee of the Society.

Although the classification of the descriptions is in
perfect, it is perhaps the least objectionable that cou
be made.

The articles are described as briefly as is consiste
with clearness, so that the size and price of the wo
might be as small as possible.

A list of some of the works consulted by the Co
piler is annexed :—

Ure's Dictionary of Arts and Manufactures.
Lardner's Cyclopædia—Manufactures in Metals.
Penny Cyclopædia.
Encyclopædia Britannica.
Partington's Cyclopædia.
Burnett's Outlines of Botany.
Burnett's Useful Plants.
Lindley's Flora Medica.
Smith's English Botany.
Loudon's Arboretum Britannicum.
Loudon's Encyclopædia of Agriculture.
Thompson's Dispensatory.

Pereira's Materia Medica.

Library of Entertaining Knowledge—Vegetable Substances.

Transactions of the Society of Arts.

Turner's Chemistry.

Graham's Chemistry.

Knight's Weekly Volume—Textile Manufactures; and British Manufactures.

Taylor's Handbook of Silk and Cotton Manufacture.

Owen's Lectures on the Invertebrate Animals.

Fleming's Molluscous Animals.

OBJECTS DERIVED FROM THE VEGETABLE KINGDOM.

CORN.

SPICES.

WOODS.

MISCELLANEOUS SUBSTANCES.

OBJECTS DERIVED FROM THE ANIMAL KINGDOM.

SHELLS.

INSECTS.

MISCELLANEOUS OBJECTS.

TEXTILE OR WOVEN FABRICS, AND THEIR MATERIALS.

OBJECTS

DERIVED FROM

THE MINERAL KINGDOM.

THE METALS.

INTRODUCTION.—The metals form a class of bodies belonging to the mineral kingdom. They are distinguished from minerals in general, not by any one character in particular, but by several taken together.

They all possess a *peculiar* brightness, very different, for instance, from that of glass or wax, or varnish;* but we must not therefore imagine that all bodies that possess this peculiar brightness or lustre are metals, for many other minerals have it.

If a sheet of polished metal be held before the fire or a candle, the heat from the fire or the light from the candle, instead of passing through the metal, as they would partly through a sheet of glass, or sinking into it, as they would into a rough black board, are thrown back again, or *reflected:* if, instead of holding the metal straight before the fire, we hold it at an angle or slantingly, the heat, instead of being thrown back, will be thrown in another direction; this will be easily proved if we stand by the side of the fire-place, so that we cannot see the fire, and get another person to hold the sheet of metal, moving it until we see the light of the fire on it, when we shall feel the heat also.

This simple experiment, which may be performed with any

* We are apt to consider lead, and some other metals, as not possessed of this brightness, from the circumstance of their tarnishing on the surface, when exposed to the action of the air; if, however, the tarnish is removed by scraping or polishing in any way, their brightness is immediately restored.

sheet of *polished* metal, as a bright shovel or the under surface of a large saucepan lid, proves that the light and the heat of a fire, on striking or falling on a polished metallic surface, are thrown off from it, or, in other words, *reflected;* and therefore metals are said to be *good reflectors of heat and light.* Many of the most important uses of metals depend on this property; for instance—metals are used to make the reflectors placed in carriage lamps, which throw the light in the direction required. Light-houses on the sea-shore are usually provided with metallic reflectors, so placed as to throw out to sea the light that would otherwise pass inland. In our kitchens, screens of bright tinned plate are placed before meat that is being roasted, in order that the heat from the fire may be reflected by them back upon the meat instead of passing into the room.

When metals are required to reflect heat or light in any direction, they should be brightly polished, as it is only when in this state that they reflect well.

If we make a bar or rod of metal, as for instance the poker, red hot at one part, we shall find that we are not able to hold it in the hand nearer to the red hot part than one foot and a half or two feet; if we make a stick of wood or charcoal red hot, we can hold it readily within an inch of the heated part without being burnt. This remarkable difference arises from the metal conveying the heat to the hand with great quickness and facility, whilst the wood and charcoal do not possess this power of conducting heat.

Metals are, in fact, distinguished among solid bodies by the ease and rapidity with which heat passes along them, and from this circumstance they are said to be good *conductors* of heat; whereas wood and charcoal are bad conductors of heat. It is from possessing this property that metals feel cold to the touch, because they carry away the heat of the skin very rapidly, and not (as is often wrongly supposed) because they are really colder than other bodies: a spoon or any other metallic substance that has been lying some time on a table, must necessarily be of the same heat as the table, both having been exposed to the same air and warmth; if, however, the hot hand is placed on the spoon, the latter feels cold, because it carries away the heat from the hand very fast; on the contrary, the table does not feel cold, because it does not possess the power of conducting the heat so rapidly.

Not only do metals possess the power of conducting heat,

they also are distinguished as conductors of another principle called Electricity, or, when it occurs on a large scale in nature, Lightning. It was from a knowledge of this fact that lightning conductors for protecting buildings and ships were first devised. A lightning conductor consists of a rod of metal, higher than the building or mast to which it is attached, and carried some depth into the earth or the sea; the use of this rod is, as its name implies, to conduct the electric fluid: being higher than the building to which it is affixed it attracts the lightning, and conveys it into the ground or into the sea. The metal allows the electricity to pass freely along it, and hence it is not injured by it; the brick and stone work of a house do not allow a free passage for the lightning, and consequently, if struck by it are, destroyed.

Of all metals copper is by far the best conductor of electricity, and should therefore always be used for this purpose.

Some few of the metals are brittle, so much so, that if struck with a hammer they break into small pieces; this is the case with antimony and bismuth. The greater number, however, on being beaten with hammers spread out into thin leaves;—this property is called *malleability,* and those metals capable of being beaten out into the thinnest leaves or sheets are said to be the most *malleable.*

Of all the metals, gold possesses this property in the highest degree; it can be beaten until the leaves are only the 282,000th of an inch in thickness.

Malleable is derived from the Latin word *malleus,* a hammer, from whence comes our English word mallet.

Another property possessed by several of the metals is capability of being drawn out into thin wires: this property is called *ductility.* Of all metals, gold is the most ductile, or, in other words, it can be drawn out into thinner wires than any other metal. The mode adopted for drawing out metals into wires is, first, to form the metal into a bar or cylinder: this bar is drawn by machinery through a hole smaller than itself, and is, of course, lessened in size and increased in length by the operation; it is then drawn through a still smaller hole; again through one still less, and so on until the wire is of the size required.

The strength of wires does not, as would be supposed, correspond with the ductility of the metals of which they are

formed; by far the most tenacious metal is iron, although in ductility it is surpassed by gold, silver, and platina.

The strength or tenacity of metals is easily ascertained, by taking the same sized wires of the various metals, and trying what weight they will bear without breaking.

We are apt to think that all the metals must be very heavy bodies: the greater number of them are so, but not all; there are some (though these are not common) that, being lighter than water, float on its surface. Others, again, as gold and platina, are the heaviest bodies in nature; the latter is more than 21 times heavier than water, and gold more than 19 times. iron, tin, and zinc are between seven and eight times the weight of water.

All the metals are capable of being melted by heat, that is, they are all fusible: they vary, however, very greatly in their degree of fusibility; the heat that always naturally exists in this country is sufficient to melt one of them, mercury. Near the north pole, however, the temperature is not sufficiently great to melt this metal, and it is, of course, there in a solid state. Some metals fuse below a red heat, as lead, tin, and zinc. The other common metals do not melt until they are heated above a red heat. It is a singular fact, that when two metals are mixed together, the resulting compound, which is called an *alloy*, melts at a much less heat than either of the two metals of which it is formed would have done separately. For this reason solder, which is an alloy formed of lead and tin, is used by plumbers for uniting pipes together, as it melts at a less heat than lead, and is consequently more manageable.

Not only are all the metals fusible, but some are even volatile, that is, on being heated they fly off in the form of vapour. The common metals that possess this property are mercury and zinc.

The metals vary much in hardness; some of the uncommon ones are as soft as wax, and can be moulded by the hand. Lead can be scratched by the nail; copper, gold, and silver are harder; zinc and iron still more so.

The metals are supposed to be simple substances, that is, they are not compounds or mixtures of several bodies. We know glass to be a compound body, because we can make it by mixing several things together and melting them. Or we can separate the various things of which it is made; but

we suppose iron and all the other metals to be simple substances, because we cannot make them, nor can we separate any thing from them. Metals are usually found not pure, but mixed with various substances, and in this state they usually look like stones, and are called ores. Thus, the minerals from which iron is obtained are called iron ores. Lead is procured from lead ore, &c. &c.

Lead.—Lead is a metal found principally, in England, in the Mendip Hills of Somerset, and in the Peak of Derbyshire, not in its metallic state, but as an ore, containing a large quantity of sulphur. This ore is called galena, or lead glance. The metal is obtained from the galena by first heating it strongly, or roasting it, as it is termed, in order to burn away the sulphur. The whole is then melted, when the lead, being heaviest, sinks to the bottom, leaving the impurities on the surface. It is then allowed to run into moulds, each of which holds about 150 lbs. The masses of lead thus obtained are termed pigs, or pig-lead. It is a bluish gray colour, very brilliant when first melted or scraped, but the surface rapidly tarnishes when exposed to the air or to water. The use of lead, as a material for making water-pipes, and for lining cisterns, depends partly on the forming of this rust or tarnish, for the metal itself is poisonous; but it does not render the water unwholesome, as the tarnish on the surface prevents any further action of the water on the metal. It is the softest of the common metals, being readily cut with a knife, or even scratched by the finger nail. When rubbed on paper a portion is left, causing a blueish gray stain. It is readily melted, fusing before it is heated to redness, and it is one of the most inelastic metals, remaining in any position in which it is bent. It is this very softness, and the ease with which it is melted, that render lead so valuable to man. It requires little labour to work it; it is easily cast into any shape, consequently it is much used. Sheet-lead is made either by casting the melted metal in sand, or by rolling it into sheets, when solid, between large rollers. It is in great use for covering the gutters or roofs of houses and other buildings; for lining cisterns, coffins, making water-pipes, &c., the ease with which the metal is cut, and the flexibility it possesses, enabling the workers to bend and adapt it to any object it is desired to cover.

The Chinese have taken advantage of the ready fusibility of lead to form the thin lead with which they line their tea-chests. A quantity of the melted metal is poured on a flat stone, and before it cools another is laid on it, which presses the lead into a thin sheet. Bullets used by soldiers are made by casting the melted metal in moulds, whilst the lead shot employed by sportsmen are made by melting the lead with a small quantity of another metal, called arsenic, to render it harder. When melted, this mixture, or alloy, is poured into an iron or copper frame pierced with holes like a cullender, through which it streams in a shower, dividing into drops, which fall into cold water; and, in order that the lead may be somewhat cooled before it reaches the water, it is allowed to fall from a great height, the shot factories being built for this reason about 100 feet high. Alloyed with one-sixteenth part of the metal called antimony, the use of which is to harden it considerably, lead forms the substance of which the types or letters used in printing books are cast. Melted with tin it forms the substance used by plumbers for uniting together pieces of metal, and which is called solder. When two metals are melted together, the compound formed is much more easily fused than either of the metals separately would be; therefore the hot iron of the plumber will melt the solder whilst there is no risk of his melting the lead or other metal he has to join. In weight lead exceeds most of the common metals; it is eleven-and-a-half times heavier than water: being so very heavy, it is often employed for clock-weights, &c.

Its ductility and tenacity are exceedingly small; it cannot be drawn into wires less than one-twelfth of an inch in diameter, and they will not support more than 20 lbs. To bear one cwt. a wire of lead would be required two inches and a half in diameter. Lead, however, can be beaten out into very thin leaves; but they possess but little strength. Use is made of the capability of lead to be drawn out in making pipes. A thick rod of lead is cast with a hole down the middle, the size of the bore of the pipe required; in this hole an iron rod is placed to keep it from closing, and the lead is then lessened in size and increased in length by being drawn by a machine through grooves in rollers gradually decreasing in size. When the pipe is sufficiently small, the iron wire is withdrawn.

When kept melted for any length of time, lead rapidly forms a dross on the surface: this substance is litharge, which is much used in glazing earthenware, and in making flint-glass, to which it gives great transparency and clearness, and lessens its liability to crack.

Red-lead is another preparation of this metal, it is also used by glass-makers, and by painters as a colour. White-lead is prepared by corroding lead with the vapour of vinegar. It is used in very large quantity to form paint. All these preparations of lead are extremely poisonous, giving to persons who use them paralytic diseases, and a dreadful complaint called painters' cholic. Besides painters, those who work with the metal, and are called plumbers, from the Latin name of lead (plumbum), are liable to these disorders.

Black-lead is a mineral substance that does not contain any portion of lead.

Copper.—The most important and valuable ore of copper is that termed copper pyrites, in which the metal is united to sulphur and iron. It is found in very large quantity in Cornwall, Devonshire, and Anglesea.

The copper is obtained from this ore by a very complicated process, during which the ore is heated to redness (or roasted) many times, in order to drive off the sulphur, and the earthy impurities are separated by their being melted away. As thus obtained, copper is of a reddish colour; it has a nauseous taste, and, when rubbed, a disagreeable smell. It is one of the most malleable of the metals, capable of being beaten or rolled into very thin leaves, and it is possessed of very considerable hardness. It is on its malleability that its great use depends. When heated it is rolled into sheets between cast-iron rollers, which are, after each rolling, placed nearer together so as to lessen the thickness of the sheet. These sheets are used for protecting the parts of a vessel that are under water, for which purpose the copper is well fitted by its hardness. Sheets of copper are also used for making copper money. Round pieces of the size of the coin required are cut or punched out of the sheet, and then by a powerful engine are stamped with the design. Sheet copper is much used by the engraver; it is not so exceedingly hard but that his steel tools will act upon it, and yet is sufficiently so for

a large number of prints to be taken from it without injury to the design.

Copper is remarkable for its great ductility and tenacity; it can be drawn out into wire smaller than those of any other common metal, except gold, silver, or iron; and in strength copper wire is superior to all, except that of iron. The use of copper wire for bells is well known, and no metal could well supply its place, iron is stronger, but then it rusts, which copper does not if not wetted. Copper is of all metals the most sounding or sonorous when struck. This property, perhaps, depends partly on its elasticity, which is very considerable. In consequence of this property, copper, when properly prepared, or some mixture of it with other metals, is always selected to form musical instruments. Among the other uses to which copper is applied is that of making utensils for cooking; but it should never be so employed, being one of the most poisonous of the metals, and readily acted on, and in part dissolved, by any substances containing acids, as vinegar or fruit, when the portion dissolved renders the whole poisonous. Many lives have been lost by persons eating food that has been left standing in copper vessels.

At a bright red heat copper melts, and then may be readily alloyed with other metals. Some of the compounds thus formed are more valuable than even copper itself. When 80 parts of copper are mixed with 20 parts of a metal called zinc, and melted together, brass is formed, an alloy of extreme value. The colour varies with the proportions of copper it contains; its value depends on its being cheaper and more easily melted than copper, and though not so hard, yet as it does not rust when exposed to the air, it is used for the making of engines, clocks, and wheels of watches. So readily and cheaply is it worked in consequence of its softness, fusibility, and ductility, that it is employed to a great extent for domestic purposes, as for pins, candlesticks, &c.

Bronze is an alloy of copper with a small quantity of tin; it is extremely hard, and was used by the ancient Romans to form cutting instruments and weapons, as iron was not known to them. In the Scripture we find constant references to its use: it is there, however, termed brass, and the articles made of it are called brazen.

The compound of which bells are made is formed of copper alloyed with tin and other metals.

The German silver now used contains copper, which is dissolved if the spoons, &c. made of it are left in vinegar or pickles, rendering the whole unwholesome.

Silver.—Silver is a valuable or precious metal that is found in very considerable quantity in the central countries of America, viz. Chili and Peru. In the mines, which usually are in the mountainous districts, the silver occurs native or in the metallic state; and being nearly pure, it is readily separated from the substances it is united with by roasting it, to drive off any small quantities of sulphur present, and then mixing the whole in mercury, which dissolves the silver and leaves the impurities. The mercury is then evaporated by heat, and is collected to be used again, whilst the silver, not being volatile, remains in the vessel. The fumes of the mercury, when thus heated, are very destructive to the lives of the workmen employed. In almost all the lead ores of this country there is a small proportion of silver, and in many the quantity is sufficient to repay the cost of extracting it.

In appearance, silver is one of the most beautiful of the metals, it being more brilliantly white than any other; and it is capable of being more highly polished than any, except steel. It is quite destitute of any taste or smell, and is not in the slightest degree changed or acted upon by water, moisture, or pure air. It is these circumstances that render silver so highly prized as a material for making utensils for domestic use. Its beautiful appearance and high polish recommend it to the eye; and as it is not acted upon, like copper, by our food, or by any acid, such as vinegar, it does not render our victuals impure or poisonous; and as it is without taste or smell, it cannot communicate either.

The value of silver, and its occurring in the earth in a metallic form, not requiring any great skill to extract it, are the causes that it was one of the metals first used by man; and we have records of its being appreciated in the earliest times.

Silver can be beaten or rolled out into thinner leaves than any other metal, with the exception of gold, and its use to man depends, in a very great degree, upon this property. Before being made into such articles as cups, candlesticks, &c.

silver is rolled into thin sheets, which are cut the required shape, and soldered together at the edges. Sheets of silver, cut into circular pieces, and stamped with a device, are used in almost all civilised countries as coins or money; and, from the high price of silver, these are used for greater amounts than coins of copper. Silver, however, when quite pure, is too soft for the purpose of making money, therefore it is usually alloyed with about one-twelfth of copper.

The value of silver prevents its being much employed by any but rich persons; but by a process termed plating, articles are formed that possess all the advantages of silver, and are not more than one-sixth of its cost. Plating is the covering of another metal with a surface of silver. If a sheet of copper is required with a face of silver, it is formed in this manner: A thick, stout bar of copper is taken, and on it is laid a thin sheet of silver. They are bound together by wire, and heated so as to make them unite. The bar thus formed is rolled into a large sheet, which still has a thin covering of silver, and may be used in the same manner as a sheet of silver. Articles that, from the shape, cannot be covered with silver in this manner, are rubbed over with some silver dissolved in mercury; the latter is then driven off by heat, and the silver remains covering the article.

Silver is one of the most ductile and tenacious metals: it is therefore much used in the form of wire, and from its strength, as well as its unchanging beauty and value, is formed into chains for watch-guards, &c. These, again, are frequently covered with gold, or gilt, as it is termed.

Besides the above uses, silver supplies a most valuable caustic for the use of surgeons; and the same preparation of it is made into marking-ink.

N.B. Plating of articles, as spoons, forks, ornaments, &c. of an irregular shape, is now done by the aid of galvanism, a kind of electricity.

Mercury, or Quicksilver.—Mercury is found united with sulphur in many parts of the earth, but the largest mines of it are in Spain and Peru. One mine alone in Spain employs about 1000 persons in working it. The mercury is obtained from the sulphur with which it is united, by placing the ore in close iron or earthen vessels along with iron or

me. The vessels are then heated to redness, and the sulphur nites with the lime or iron, whilst the mercury is set free, nd, being volatile, passes off in vapours which are cooled, hen they condense into the fluid metal. Mercury is a metal f a very brilliant lustre and a white colour, resembling lver. It is the only metal that is melted by the warmth f our climate. Near the poles, and even in some parts of iberia, in winter it is solid, but when brought to warmer limates it melts; in this country it is always fluid. A small rop of mercury, placed on a flat surface, retains a round orm, for it does not adhere or stick to those objects with hich it is placed in contact—hence it readily rolls about if he surface on which it be is at all inclined, and this power of olling readily over sloping surfaces, and its colour, have ained for it the name of quicksilver. It is very easily ivided—a drop allowed to fall on the table separates into n immense number of little globules, each of which retains s round form, and runs about readily if the surface of the able be not quite level. Mercury is quite free from any taste r smell, and in the state of a metal is not poisonous. The se of mercury in the arts depends partly on its being a vola- ile substance, and on the readiness with which it combines ith other metals forming compounds termed amalgams. ilver is extracted from its ore by being placed in contact ith mercury, with which it unites and becomes dissolved; he compound is then heated strongly, and the mercury is riven off in vapour and is collected for future use, whilst the ilver remains behind. It is used in the same manner in sil- ering or plating small objects. (See Silver.) It unites eadily with the common metals, tin and lead; advantage is aken of this circumstance in forming looking-glasses, which re backed with a compound of tin and mercury. A small piece f glass may be easily made into a looking-glass, by taking a iece of tinfoil (which is merely tin beat out into thin leaves); n this, which must be very smooth, some mercury is to be pread quite evenly, and both covered by a piece of very mooth paper; the glass is then to be laid upon the paper, nd pressed down, whilst the latter is pulled steadily away, hen the glass and the mercury will come into contact, and if he operation has been skilfully conducted there will be no air ubbles, as they are drawn out by the paper; if a weight is

then put on the glass, so as to press out the excess of mercury, a very tolerable mirror is the result. Large glasses are made on exactly the same principle. The weight of mercury is very great—it is thirteen times heavier than water; this circumstance, together with its being unchanged by the air, and its fluid state, render it of great use in making philosophical instruments.

It is also used in medicine when combined with other substances. One very useful preparation of mercury is calomel, and it also yields corrosive sublimate, a medicine of very poisonous properties, which is much used for preventing the dry rot in wood and cordage.

Pewter.—Pewter is an alloy formed of different metals according to the use to which it is to be applied. The common pewter dishes and measures for beer are made of tin, with one-twentieth of its weight of copper melted together. The uses of pewter depend upon a quality common to all mixtures of metals, that they melt more easily than simple metals; pewter melts readily, and is without trouble cast into any required shape. When cold it is inelastic, and will bend to some considerable extent without cracking; thus it is advantageously employed for measures which are exposed to great violence, as, if it is knocked out of shape, it can be restored by beating. Compared with copper and other metals that might be employed, it is cheap, and it answers where cast iron would not, being too heavy and liable to crack; it is also sufficiently soft to allow any name or address to be engraved on without much trouble, and therefore cheaply.

Britannia metal may be regarded as a superior kind of pewter, and, like the latter, its use depends on its cheapness and on the ease with which it is melted, and on its softness, enabling it to be turned in a lathe, and cut of any required shape.

Iron.—Iron is, of all metals, the most useful and really valuable to man—and, by the kind care of the Creator, it is one of the most abundant. It is found in every country in soils, in rocks, and in quarries, combined with other substances in the form of various ores, but it is very rarely met with in a metallic state. The most useful of all the ores of iron is that which is termed clay iron ore, because the iron is united

with a large quantity of clay. It is from this ore that the iron used in this country is obtained; the first process is to roast or heat the ore for some time, so as to drive away any small portions of sulphur which it may contain; it is then mixed with coke and lime, and the whole thrown into immense furnaces, lighted, and kept at an intense heat by blasts of hot air, forced in by steam-engines; the use of the coke is to supply the heat as it burns, while the lime unites with the clay and earthy matters of the ore; and forms an easily melted mass, which is allowed to escape. The melted iron, being the heaviest substance in the furnace, sinks to the bottom, and every twelve hours is allowed to flow out into channels made in sand. The shape of these channels into which the melted iron runs and cools, has caused the workmen to call the iron pig-iron, and it is always known by this name in commerce. Thus obtained, iron is usually very hard and brittle, and is melted without much difficulty and cast into various articles; hence it is frequently termed cast-iron.

In order to form iron fit for the blacksmith's use, or forged iron, as it is termed, the cast iron is melted by an intense heat, and exposed to the air for about two hours; it is then cooled suddenly, and again heated in another furnace until it melts; after a short time it begins to thicken, when it is taken out and beaten by heavy hammers, and rolled under immense pressure whilst still hot—by these operations its nature is much changed—it is no longer brittle, but excessively tough and strong — infusible, and, to a certain degree malleable.

Forged or malleable iron, as thus produced, is usually of a grayish white colour, with a slight shade of blue. It is ductile to a very great degree, for it can be drawn into wire less than a quarter of the size of human hair. It also possesses a very considerable power of malleability, for it can be rolled or hammered into sheets, although not into such excessively thin leaves as gold, silver, or copper can; but the quality that renders iron of such extreme use to man is its immense strength and toughness, or tenacity—in which quality it exceeds that of all other metals: if a chain or wire be required of great strength, iron is taken to form it; if a tank or vessel to hold large quantities of water is made, it is of iron, because it is the strongest as well as the cheapest material that could be

employed. Forged iron, although it can scarcely be melted by the most extreme heat, is readily worked into any shape—for when heated to bright redness, or to whiteness, it becomes sufficiently soft to be moulded by the heavy blows of a hammer, or to be cut or punched with holes by the tools of the blacksmith. Iron possesses an invaluable property that is not found in any other common metal; it is that of welding: when two pieces of iron are heated to whiteness and hammered together, they unite firmly, and are as strong at the place where they are joined as elsewhere. Without this property iron chains could not be made without soldering, and then the strength would be so much lessened that they would not be fit for the uses to which they are now applied, as for cables, harness for waggon horses, &c. One would be apt to imagine that so strong a metal would necessarily be very heavy; but as, if it had been of very great weight, iron would not have been so useful to man, it has been benevolently ordered by a kind and thoughtful Providence that it should be very light compared with the other metals: it is much lighter than silver, copper, or lead.

Not only is iron valuable to us as a tough and somewhat malleable metal, but we possess the power of rendering it very hard, and of removing this ductility: this is done by cooling iron suddenly, by plunging it into water. The blacksmith, after making a hoe or a ploughshare, renders it still more valuable by hardening it as much as possible, as, after it is once formed, it is not required to be malleable; he does this by plunging it whilst hot into water; and if at any time it should require altering in shape, it has only to be heated in the forge, and it again becomes malleable.

Besides all these properties rendering it so valuable to man, iron possesses another not less important than any of those before mentioned. If bars of the best iron are taken and surrounded with powdered charcoal, and then heated to whiteness for some days, it is much changed in its appearance—it has become excessively hard, and much more elastic than before, and is called Steel. It is of this material that penknives, scissors, razors, table-knives, and all cutting instruments are formed; the steel springs of bells and watch-springs are also made of this substance. It may strike us with surprise that so brittle a body as a pen-knife, and so elastic a one as a watch-spring, can be formed of the same material;

but steel can be altered in the same manner as iron is: by being suddenly cooled it becomes very hard and brittle, but if it is cooled very slowly it is elastic and not so hard: by attention and experience the workman is enabled to give the exact degree of hardness required to all steel instruments. Both iron and steel are capable of being highly polished, and when exposed to dry air they undergo no change, but if there is much damp they become rusty. The rust of iron, however, unlike the rust of copper, is not unwholesome, but, on the contrary, it is, as well as many other preparations of the metal, used as a strengthening medicine.

Iron is also used in dying black and in making ink. (See Ink and Nutgalls.)

The needle of the mariner's compass, which always points to the poles, and so enables him to steer his ship across the pathless ocean, is formed of iron or steel rendered magnetic, either by rubbing with a loadstone, or other means: not any of our common metals could be used for the same purpose.

MINERALS.

Chalk.—Chalk is a mineral substance consisting of lime, the acrid and caustic properties of which are destroyed by its being united to an acid gas. This acid gas is given off if the chalk is placed in a stronger acid, such as vinegar.

When chalk is heated to redness, this gas is driven off by the heat, and caustic lime remains. It is in this way that lime is formed, by burning the commoner kinds of chalk or limestone in kilns.

Chalk is one of the most common minerals. It forms several ranges of hills in the south of England, which are distinguished by their rounded summits

Limestone is an impure kind of chalk. Marble is of the same nature as chalk, only of a harder texture.

As chalk lies near the surface, it is not obtained by mining, but by simply digging pits or quarries.

Chalk is an article of very extensive use; it is of great value to the farmer, from its improving the quality of clayey lands. Its white colour and friable texture render it useful for drawing, or writing on slates, wood, &c.

When chalk is finely powdered and mixed with water, the latter becomes turbid or milky, from the finer particles being suspended or held up in the water, while the coarser sink to the bottom. If the water is poured off, it carries all the finest powder with it. On being allowed to stand undisturbed for some time, this settles at the bottom; it is collected and sold under the name of whiting, for cleaning metals, &c.; and when mixed with glue and water, it forms whitewash.

Chalk is used occasionally as a medicine, to correct acidity in the stomach; for the same purpose it is placed in calf-pens for the animals to lick.

Clay.—Clay is an earthy substance, which is readily distinguished by its forming a soft, inelastic, ductile mass when moistened. It is opaque, and usually possesses a very

peculiar odour (clayey). Clay, when pure, is white, as we find pipe clay and porcelain clay; but in general it is deeply coloured by the mixture of other substances. The greater part of the clay near London is of a bluish tint; other kinds are of reddish brown, brown, &c.

Few mineral substances are of more importance to man than clay; its great use in the arts arises from the valuable property it possesses of becoming extremely hard when exposed to great heat. From its softness and ductility it can be formed into any required shape, which is readily fixed by burning. Before the clay is made into vessels, sand or flint finely powdered is mixed with it (see China), which prevents it becoming cracked in burning. Vessels formed of baked clay are hard, brittle, opaque, and porous, permitting water slowly to pass through them; therefore, before use, they require to be glazed. A description of this process is inserted under the article "China." The coarser kinds of clay are manufactured into bricks and tiles; the clay being shaped in moulds, is dried in the sun, and baked in kilns.

Clay is also used to form the bottoms of ponds and canals to prevent the water draining away; as the soft mass it forms, when moistened, does not permit water to soak through it.

All soils, except sandy heaths and deserts, contain a large portion of clay mixed with the sandy and vegetable substances that form the soil. Good loamy soils, when dry, contain at least one-half their weight of clay.

Coal.—Coal is the name used by us to signify a black, brittle, inflammable substance, found sometimes near the surface, but usually at a considerable depth under the earth. The word was originally applied to any substance used for fuel, and in this sense it occurs frequently in the New Testament. The general use of mineral, or sea coal, as it was formerly termed, from being brought to us by sea, did not prevail in London until little more than 200 years ago. From its stony appearance, and being dug out of the ground, coal is usually considered as a mineral substance; but there is no doubt of its being the remains of vegetables. It is not uncommon to find pieces of coal distinctly fibrous like charcoal. In many mines the remains of trees and plants are found only partly converted into coal; even the leaves

and fruits are sometimes seen. So perfect are many of these parts, that it has been ascertained that coals are the remains of such plants as fir-trees and ferns, &c., of a kind that we are not now acquainted with. Coal is found in beds or layers, deep under the surface of the ground; each of the layers is usually from three or four, to eight or nine feet in thickness, and they lie one over the other separated by layers of rock or stone. Sometimes the stone between the layers of coal is ironstone, which is also valuable.

The process of obtaining coal is termed mining, and as the expense is very great, mines are usually worked by a company of persons. When by boring down into the earth coal is discovered, an immense well, eight or ten feet in diameter, is dug, and, if necessary, the sides of it are bricked all round. This well is called a shaft. When it is dug down to a layer or seam of coal, they make large passages about twelve feet broad, and as high as the layer of coal is. There are usually two of these passages made at first, extending in opposite directions; the coal which is dug out of them being drawn to the surface by a large steam-engine placed there. From these two large passages proceed others of a smaller size at right angles; and at last a large number of passages are formed (like streets in a town), and they are separated by immense square pillars of coal left to support the roof. If the mine becomes larger, a second shaft has to be dug, in order that all the foul and explosive air that is frequently given out by the coal, should be carried out by a thorough draught of pure air, which is caused to rush down one shaft, and up the other. The draught is directed by doors being shut across passages, where it is not required.

The dangers of working the mines are many: sometimes the roof falls in, crushing the workmen; sometimes large springs open into the mine, drowning many; and gas escapes from the coal, which takes fire from some light coming in contact with it, killing all in the mine; or a suffocating gas chokes them. The explosions are now much prevented by the use of a lamp inclosed in a case of wire gauze, which prevents the flame passing out so as to set fire to the gas.

Coal is a black brittle substance, inflammable at a red heat, when it burns with much flame, from the gas that is formed. The use of coal for fuel is very great, not only for our houses,

but for manufactures; without coal no iron could be obtained, nor glass, nor porcelain, nor, in fact, any of the numerous things formed by the aid of furnaces. Besides these purposes to which coal is applied, when heated in iron vessels, it gives out gas, which is carried by iron pipes to the houses in towns, and is of great use in lighting the streets at night. After the coal has given out its gas, it is still very valuable, as it burns with a clear fire without flame or smoke; in this state it is called coke. From the gas factory, tar and several other substances are produced.

Emery Powder.—Emery is a very hard opaque grey mineral, commonly found in large shapeless masses at the foot of several mountains in the islands of the Grecian Archipelago. Small quantities are also found in our own country in iron mines, &c.

Emery is a substance of extreme hardness; it is in consequence of its possessing this property that it is so very useful in the arts as a polishing material. To fit it for this purpose, it is powdered in large iron mortars, or steel mills; the finer parts are then separated by mixing the powder with water, and allowing the coarser particles to subside, when the water containing the finer powder is poured off, and after long standing the latter sinks to the bottom. By this operation emery is reduced to a very fine powder; so fine, that it will polish metals, &c. without scratching them. Emery powder thus formed is used in various arts. By lapidaries, for grinding and polishing precious stones; by opticians, for polishing glasses; by cutlers, in finishing their instruments; and also by masons in polishing marble.

Emery is also used in making emery paper. A strong cement is spread upon strong coarse paper, and powdered emery of the requisite degree of fineness sprinkled on it. When dry, this paper is much used in cleaning iron instruments of various kinds.

Flint.—Flint is a mineral substance of extreme hardness, but very brittle, and, when broken, yielding sharp-edged pieces. When struck against iron or steel, its sharp edge and excessive hardness enable it to cut away a piece of the iron, which, being heated to redness by the force of the blow,

flies off in a bright spark. Hence, before the introduction of chemical matches, a flint and steel, with some easily inflamed tinder and a sulphur match, were the usual means employed in obtaining an artificial light in this country. Flints are usually of a blackish brown colour, and, when thin, are semi-transparent. They are found in immense numbers amongst the beds of chalk in this and all other countries. When heated to redness, flints lose their colour, becoming greyish white and perfectly opaque. In this state, they are extensively employed in the manufacture of all kinds of pottery ware. (See China.)

Flints are used in countries where they are large and abundant, for building houses, &c.; for which purpose they are well adapted, as the rough surface gives a firm hold to the mortar, and their indestructible nature resists every change of weather. They are also used for road making, but for this purpose they are not well fitted; as, from their extreme brittleness, they are rapidly ground to dust; at the same time, their hardness wears away with great quickness the shoes of the horses, and even the iron tire of the wheels.

They are also employed in gun-locks for lighting the powder in the pan. For this purpose, they are cut into a peculiar shape by the dexterous blows of hammers and the use of a chisel, which is fixed, the flint being struck on the edge. So expert do the workmen become by practice, that one man will in three days make a thousand gun flints.

Salt.—The valuable substance known by the name of salt is found in the greatest abundance in nature, and in situations where both man and animals can easily obtain it. Thus the waters of the ocean contain a very large quantity, and in order to produce it from them, nothing more is required than to allow the water to evaporate, when the salt remains behind. In this manner an immense quantity is annually procured in England and in other countries.

Formerly the water was allowed to evaporate in the open air, aided by the heat of the sun; but the plan now pursued is to boil away the water in metal pans. In the interior of different countries a great number of salt springs and lakes arise, from the waters of which salt is obtained in a similar manner.

Large solid beds or layers of this substance, several yards in depth, are found in many places under the surface of the earth; when thus found, it is called rock salt.

In England it occurs in the greatest abundance at Northwich, in Cheshire. It is found there in two layers; the one nearest the surface is about thirty to fifty yards under ground, and it is about twenty yards thick. The salt, however, is coloured, like coarse sugar candy, and is rendered impure by being mixed with earthy substances. Below this is a layer of stone, in its turn resting upon a bed of salt forty yards thick, which is generally perfectly transparent and colourless.

From these various sources 500,000 tons of salt are annually obtained for the consumption of England alone.

From whatever source procured, salt, if pure, is a white crystalline solid, of a peculiar taste, readily soluble in water, to which it imparts its peculiar taste, and whose weight it increases. It is one of the most important minerals to man; its use as a wholesome seasoning to food is well known. It has also the valuable property of keeping flesh from putrefaction, and it is therefore employed in preserving meat for sea voyages.

It is used in immense quantities in curing or drying fish, as cod, herrings, &c.

It is extremely beneficial to domestic cattle, and is much liked by them; the fattening effects of the food in the salt marshes of the coast is well known. The wild animals of many parts often perform long migrations in order to obtain this substance.

Salt is used as a manure in some peculiar soils, and also for the glazing of very coarse earthenware; and in all chemical factories it is extensively required.

That a substance so invaluable to man should be so abundant, and so universally distributed, is one of the proofs which so continually present themselves, of the foresight and goodness of the Creator.

Sand.—A hard granular mineral substance, formed of the same material as flint; which occurs in some places on the surface of the ground, in others under the surface; it is also found forming the beds of many rivers, and the shores of the sea.

Where the surface of the earth is to a great extent covered with sand, it is called a desert, or downs.

Deserts of sand of an immense extent are extremely common in Africa, Arabia, and Persia. The sands forming them are blown about by the high winds like the waves of the sea, burying caravans of travellers and camels. Other dangers assail those who venture across these deserts; springs seldom occur, and if the water they carry with them is exhausted, all must perish of thirst.

In our own country downs of sand are not uncommon. They are formed by the waves of the sea, driving a quantity of fine sand on the beach; this is carried forward by the wind when it blows inland, and is deposited. Sometimes even a large tract of country is thus converted into downs, and villages and towns have been gradually overwhelmed by mounds of sand. This event occurred some years ago to the town of Findhorn, on the coast of Morayshire, where a fertile and highly productive district of ten square miles in extent has been rendered barren by being gradually covered with drifting sand. The same effect also takes place on the west coast of the Hebrides; the inhabitants, however, partly succeeded in preventing it, by setting reeds and grass in the sands; these take root, and thus bind the sands together.

Sand is a material of great value for many purposes in the arts. The whiter kinds are used extensively in making glass (see glass). The coarser kinds are used for making mortar (see mortar); and also in brickmaking; for manuring heavy clay soils, which they render lighter and more pervious to water, and thus allow the roots of plants to penetrate more freely.

Sand is also useful in cleaning and scouring, by its gritty nature helping to remove dirt; and some kinds are used to make the moulds in which melted metal is cast for cannon, and in which iron, brass, and other metal articles are cast.

Slate.—Slate is a kind of stone not crystallized, but foliated, or composed of flat layers, which may be easily separated from one another. In colour it varies very much; the most common is bluish black; other kinds are green, brown, bluish, &c. Slate is not a very heavy stone, it being about three times the weight of water.

The slate used in this country is dug out of the open

quarries of Yorkshire, Westmoreland, Wales, and Derbyshire, &c. It is obtained in large flat pieces by means of wedges; and these are again divided into thinner portions, by the use of smaller wedges. Some of the larger and thicker pieces are sawn, like stone, into the required shape.

Slate, from its lightness and its being impervious to water, is much used for covering roofs of houses, &c. When applied in this way, it is split into layers of the required thickness; these are pierced with holes and fastened with pegs to the laths of the roof, the top ones being made to overlap the lower (like the scales of a fish) so as to keep out the rain. For this purpose pieces are taken that are very free from pores, smooth, and that split readily. It is ascertained to be free from pores by placing a portion in water, weighing it both before and after it is put in; if it is found to have increased much in weight by absorbing water, it is not used for roofing, as such slate not only allows the rain water to soak through and rot the wood work underneath, but it becomes covered with mosses, which also retain the moisture.

Writing slates are made from the smoothest pieces; these are split when fresh from the quarry, as they divide more readily at that time. They are then ground smooth with fine sand, and in that state used for writing on with slate pencil, which is nothing more than the softest and most splintery kind of slate cut up into the required size.

Slate is now getting into use for many purposes to which it was not formerly applied; thus it is sometimes used for grave-stones, chimney-pieces, for paving, and also for making water cisterns: for which purpose the less absorbent slabs are well adapted, as they neither absorb the water, or even grease, should it come in contact with them. For this reason slate cannot be painted, as the paint readily peals off when dry. Inkstands, slabs, and various small articles, are now frequently made from slate.

Hearthstone.—Hearthstone is the soft stone which, from its friable nature, is employed in whitening the doorways and hearths of houses. It is a kind of limestone, less pure than chalk and considerably harder.

The great use of the various limestones to man is for the production of lime, which they all yield when burnt, though

of various degrees of purity. The furnaces in which limestone is burnt are termed limekilns. They are filled with alternate layers of limestone and turf, or more frequently coal. The latter being set fire to, heats the limestone to whiteness, and converts it into caustic and acrid lime. As thus obtained, lime is of immense value to man; being employed in the manufacture of mortar (which see)—cements—in the preparation of leather—in bleaching—and to a vast extent in agriculture, as a manure. The harder kinds of limestone are extensively employed as building stones, under the names of Bath stone, Portland stone, &c. &c. They are conveniently used for this purpose, being easily sawn of the required shape; but, in point of durability, they do not equal many other stones.

MANUFACTURED ARTICLES.

ALUM.—This substance is found, occurring naturally, near volcanoes. It is also prepared by a chemical process, from a kind of bluish-grey slaty mineral, found at Paisley, and at Whitley, in Yorkshire, at which places are the chief alum factories of this kingdom.

Alum is a saline substance, soluble in water; and on the water being allowed to evaporate, it is left in the form of crystals, in which state it is usually sold in the shops.

It contains so much water—nearly half its weight—that when heated it melts, and the water gradually boils away, leaving a dry white powder, which is sold by the chemists as burnt alum. The taste of alum is astringent, but at the same time sweetish. It is transparent and colourless. The uses of alum in the arts are very numerous, as, in the manufacture of many colours for painters; in dyeing, and in printing calico. In preparing some kinds of leather it is much employed (see Leathers). Candle makers use it to harden and whiten tallow; and bakers to whiten the bread; the latter should rather be termed an abuse than a use, as it is injurious to the health. Alum is a valuable medicine, acting as a powerful astringent; hence it is used, when dissolved, as a gargle in relaxed sore throats; and it is also employed to stop bleeding from leech-bites.

CHINA, EARTHENWARE, AND RED WARE.—These three substances, which are sometimes classed together under the name of pottery, are so much alike in their composition and manufacture that it would occasion great repetition to describe

them separately. It will be better, therefore, to treat of their manufacture together, and state the points in which they differ afterwards.

The ingredients used in making pottery, are clay and flint. The quality of the clay is of great importance; that used in England is principally brought from Dorsetshire and Devonshire (although, for making china, a very superior kind is obtained from Cornwall). The clay is mixed, usually, by the aid of machinery, with very pure water, until it is of the thickness of cream. This mixture is strained through lawn sieves, in order perfectly to separate from it any grit. The flints used are burnt in a kiln, and, whilst red hot, thrown into cold water; this renders them brittle, and, consequently, more easily ground. When they are reduced to powder, which is done in a mill, they are mixed with a large quantity of water, and much stirred, or agitated; this causes the finer parts to mix with the water, while the coarser powder settles at the bottom. The water and the fine powder are then drawn off, and allowed to stand for some time, when the latter settles at the bottom, and the greater part of the water is poured away.

The potter then mixes together, in a large vat, the requisite proportions of the clay and water, and the flint and water. When the whole is thoroughly mixed, it is passed several times through a fine silk sieve, not only to ensure its freedom from grit, but also its perfect uniformity. This mixture of clay, flint, and water (which is called *slip*) is then pumped into a boiler, or kiln, and the water evaporated, or boiled away, until the mass is left of a proper consistence for working. As soon as removed from the kiln, it is beaten with wooden mallets, in order to expel any air it may contain, and is then fit for being formed into the different vessels for which it is designed.

The clay thus prepared is formed into the shape of the vessels required, in three different ways. The first method is called by the workmen throwing, and is performed by means of the potter's wheel. This consists of a small round table, at which the potter sits, and which is turned round and round by an assistant working a handle. On this table, or wheel, articles of a circular or round form are made. A lump of prepared clay, and flint, of the proper size, is thrown upon the

centre of this table, which is then put in motion by a woman, and as it turns round with the clay, the thrower, or potter, fashions or moulds the latter into the desired shape, forming a hollow in it, by pressing with his thumbs in the middle, drawing it out at the edges, and moulding it until it is finished. The table, or wheel, is then stopped, and the article is separated from it by drawing a wire underneath. It is then carried to a wareroom to harden.

The articles made by the potter's wheel are rough, and not finished in shape. A teacup, for instance, has not the foot nicely formed; it is not hollow underneath, or round at the edge. In order to give the articles the exact shape required, they are turned in a lathe, like that used by wood turners, and cut and smoothed with iron instruments. Such vessels as require handles and spouts, are taken, after being turned, to the *handler,* who forms the handles, &c. in moulds, and fixes them on with soft clay, or *slip.* There are, however, many oval or angular articles, such as cream jugs, &c. that cannot be formed by the potter's wheel; these are made by pressing the soft clay into moulds of the required shape, made of plaster of paris.

Plates, saucers, and other flat articles, are formed by pressing the soft clay on moulds, which are the shape of the inside of the saucer, &c., and smoothing the outside.

In whatever manner the vessels are formed they are allowed some time to become dry, when they are carefully placed in large clay boxes, called seggars, and baked in an oven, or kiln. When first put in, the fire is moderate, but it is afterwards increased, until the whole is brought to a white heat. Baking the article occupies about forty-eight hours, and the oven is allowed gradually to cool for twenty-four hours before it is opened.

The pottery, after baking, is hard and firm, but, at the same time, porous, and not waterproof. In this state it is called biscuit, or biscuit porcelain.

The next operation, is to form on it the patterns which are to ornament it. This is done by first printing the patterns in the desired colours, on tissue paper. The pattern is then cut out from the sheet of paper, and pressed upon the vessel, which being porous, absorbs the colour; the tissue paper is then washed off, and the colour dried in by heat.

To render these porous vessels fit for holding liquids, they must be glazed: this is done by dipping them in a liquid, which is generally formed of white lead, ground flint, and water. They are then heated in the glazing oven to a sufficient degree to melt the glaze, which runs over and covers the surface, rendering it impervious to water.

The difference between china, earthenware, and red ware, is simply owing to the different kinds of clay and other materials used. For china, a very pure white clay is necessary: this is obtained from Cornwall. In the manufacturing, the china is so highly heated as nearly to melt; thus it becomes semi-transparent. For earthenware, a less pure clay is obtained from Dorset; and for the coarse red ware, a large portion of common red clay is used.

Chloride of Lime.—This substance is formed by placing fresh burnt lime in chambers or closed vessels, where it is exposed to a gas called chlorine; which it absorbs in great quantity, and acquires its peculiar odour. The gas chlorine is distinguished by several remarkable properties; it possesses a most peculiar odour, it destroys all vegetable colours placed in it—hence its great use in bleaching; it also removes infection, or any unpleasant smell arising from decaying substances. It is, if breathed in small quantities, extremely wholesome; but if much of it is mixed with the air, it is irritating to a very great degree. The use of chloride of lime depends on the fact that if exposed to the air, it gives out its chlorine: and in such a gradual manner, that the unpleasant effects of the gas are not produced, whilst enough is set free to destroy bad smells, or prevent infection. If it is required to purify a room more rapidly, some acid, such as oil of vitriol and water, may be added, when the gas is given out much more rapidly.

It is recommended that all school-rooms in close and crowded districts should be fumigated with this powerfully disinfecting gas once a week at least. If after school-hours a small quantity, such as an ounce or two, of chloride of lime be placed in a saucer, and a small quantity of oil of vitriol, with three times its bulk of water, be added to it, chlorine is given out; if then the doors, &c. be closed, the room will be completely purified by the morning. If not done in ordinary

periods, it is the bounden duty of all persons in authority over schools to see that during the prevalence of infectious disorders, the school-room be not the means of conveying death into many families. This may be readily and effectually accomplished by fumigating with the gas as described. Immense quantities of chloride of lime are used in bleaching calicoes, linen, &c. &c.

Glass.—*White Glass, and Green Bottle Glass.*—Glass is an artificial mineral substance, made by melting together sand or flint, and an alkali, either potash or soda. The invention has been known to man many hundred years, perhaps, before the Christian era. Neither the date nor the mode of its discovery are certain, though it is sometimes stated that it was found out by accident; and that some sailors making a large fire on the sea beach, the potash contained in the ashes of the wood they used united by the heat with the sand of the beach and melted into glass. This occurrence is supposed to have taken place on the coast of Syria, where it is certain that glass was first manufactured.

In England the manufacture of glass is now brought to as great a degree of perfection as in any other country. The materials used for flint or white glass are sand, potash, the preparations of lead, termed red lead, and litharge; with a small quantity of some other mineral substances. These, after being well purified, are perfectly mixed, and are then melted together; being exposed to an intense heat in large melting pots made of clay, and built into an immense furnace. The sand and potash are the essential articles in the making of the glass; but the lead is added in large quantities, as it is found to make the glass melt much more readily, also to give it greater brilliancy, and to render it less liable to crack. When these ingredients are thoroughly melted and united (which process usually takes two or three days) the mouth of the melting pot is opened, and the liquid glass within is ready to be formed into any shape desired, by the workmen. The mode adopted is, to take on the end of an iron tube some of this substance, which is then in a moist, tenacious, and plastic state, and to blow through the tube and roll the soft mass on flat iron plates, pressing it with various shaped tools. The workman at last fashions it to the shape desired, which it

retains when cold. Perhaps no other substance known could be moulded into such a variety of forms; for melted glass seems to exceed all things in its ductility and tenacity. Its consistence is something between that of soft putty and treacle, neither solid nor liquid, but capable of being bent, blown out, pulled, pressed, twisted, or cut, so as to assume at the will of the workman the various forms required. When the glass articles are made, they have to be annealed, that is, cooled slowly in an oven formed for that purpose; if they did not undergo this process, they would crack on the slightest blow, and would not bear warm liquids, &c. The qualities that render glass so valuable when manufactured, are its hardness, and the polish of its surface, which renders it so readily cleaned when soiled—its beautiful transparency, enabling us to perceive its contents when it is used to form vessels for liquids—its being so incorrosive that it is not acted upon by any ordinary substances, not even by the strongest acids, with one exception. Its value, again, as a substance for glazing windows, depends on its transparency and its insolubility; so that whilst it admits the light, and even the warmth of the sun, it perfectly excludes the wind and wet, and even to a great extent the cold. It is, in fact, only the circumstance of its being so common, so constantly before our eyes, that renders us usually insensible to its exceeding value and its great beauty.

Although glass readily allows the light to pass through it, yet when it is made into certain shapes it has a great effect upon the light, sometimes bringing it into one point, &c.; such pieces of glass are termed lenses, and are used for making telescopes, microscopes, &c., and singly for spectacles.

The dark green glass of which wine bottles are made, is merely glass of the coarsest kind; it being made of the common dark coloured sand, and the coarsest alkali.

Key.—The use of this instrument is so well known, as scarcely to need description. Its value depends upon the circumstance of the lock it is made to open being so formed, by a number of thin pieces of metal, termed wards, placed in its interior, that the key, to open it, must have a part filed away to correspond with each ward, so that it may turn round and push back the catch or bolt. The parts of the key

are termed by the maker the bow, the shank, and the bit. Until within about thirty years, keys were made by being hammered out of a bar of hot iron on an anvil; they are now formed by placing a piece of iron of the required shape, previously heated, under a powerful stamp, which forms the bow, the shank, and bit; the key is then filed smooth, the shank bored or turned, and is then sold to the locksmith under the name of a blank. It is from these blanks of various sizes that the locksmith prepares keys, filing the bits so as to suit any lock they are making.

Mortar.—Mortar is a substance which, from possessing the power of hardening gradually from a soft state, is used for the purpose of cementing together the bricks or stone used in building.

Mortar is formed of lime, fresh burnt and slaked, and sand; water being added in sufficient quantity to make the whole mixture a soft paste, when the materials are well worked up together. The proportions employed are usually one bushel of lime and one bushel and a half of sand; but, for particular purposes, these quantities are varied. As thus formed, the mortar is spread between the bricks, &c. of a building, and, by being exposed to the air, it gradually hardens, from the water evaporating, and also from the lime undergoing a change which renders it insoluble in water; therefore, mortar which has hardened or *set*, as it is termed, is not softened when exposed to wet, hence its great use in building.

Needles.—These small, but at the same time exceedingly valuable instruments, are made in immense numbers in this country, both for home use and for exportation. The materias from which they are made is soft steel wire of the required thickness: this is bought by the needle-maker in large coill, each of which contains enough wire to make many thousand needles; the coil is divided into pieces the length required for two needles, which is usually about three inches; large shears are used capable of cutting 100 wires at once. Many thousands of these pieces are then taken and made into bundles, being kept together by a ring of steel at each end; they are then placed in a furnace and heated to redness, when they are taken out and laid on a flat iron plate; the worker then

with a steel bar rolls the wires (still kept together by the rings at each end).

After this stage of the manufacture, the wires are perfectly straight, of the required length for two needles, blunt at each end, and dull from having been heated in the furnace. The next step is to grind a point at each end of the wire: this is done very quickly by the aid of a small grindstone revolving very rapidly. The grinder takes from fifty to 100 of these wires between the palm and fingers of his hands; and as he presses them against the quick moving stone, he so guides his fingers as to cause all the wires to roll round, and thus be ground to a point. So expert do the grinders become by practice, that they will point a handful of these wires, about 100 in number, in half a minute, or about 10,000 in an hour. Whilst being ground, each wire of the 100 sends out a stream of sparks, and together they form a bright glare of light. Pointing the wires is the most unhealthy part of the manufacture; for the fine dust is carried into the lungs of the workmen, and destroys them in a few years, not many living beyond the age of forty.

The wires thus pointed at each end, are taken to the stamping machine; which is nothing more than a heavy hammer of about thirty pounds weight moved up and down by a lever worked by the foot. The under surface of this hammer is so formed, that when the workman lets it fall upon the wire midway between the two ends or points, it forms the gutters or little grooves in which the eye is afterwards made; and the anvil on which the wire rests when the hammer strikes it, is likewise so formed that it makes the two grooves on the other side of the wire.

Besides making the grooves, the stamper, or hammer, partly makes the eyes for the two needles. The wires then go to a boy, who takes a number of them in his left hand, spreading them out flat, whilst with his right he works a press moving two hard steel points or piercers; and as he places each wire beneath the points, he works the press, and the points come down and cut out the eyes for the two needles. Each wire now nearly resembles two rough unpolished needles fastened together in a straight line, by their heads; and as it would take much time to divide each wire separately into two needles, a little contrivance is adopted by

which many are divided at once. A boy takes two fine wires in his right hand, and, holding them close together, he *spits* or *threads* the double needles upon them, and they are then taken to the filer, who separates each bundle into two halves, each of which consists of a number of rough unpolished needles strung on a fine wire. As it is possible that during the numerous operations the needles may have become bent, they are rolled under a steel bar to straighten them: this process is done by hand. They are then hardened by being heated in a furnace, and then suddenly plunged into cold water or oil. After hardening, they have again to be heated to temper them, so that they may not be brittle. They are again straightened by being hammered on small bright anvils with tiny hammers by girls; and now they are finished all but the polishing and packing up. The first is accomplished by taking about 20 or 30,000 needles, laying them straight side by side upon a piece of thick canvass; they are then smeared with oil and emery. The canvass is rolled up, and rubbed under a press like a mangle, for many hours; after polishing they are examined, and the broken ones removed. Should drilled-eyed needles be required, they undergo another operation, the object of which is to take off the rough edge of the eye, and to polish the head more completely: but this is only done to the finest kinds; lastly, they are counted in bundles of twenty-five, and inclosed in small papers for sale.

The chief place for the manufacture in England is Redditch, in Worcestershire, where, it is stated, 70,000,000 per week are manufactured.

NAILS.—Nails are small instruments (usually made of iron) used for the purpose of fastening together separate pieces of wood, or other substances. Each nail consists of three important parts, the point, the shank or body, and the head. The use of the point is to enable the nail to enter the wood more readily, when struck by the hammer, and also to lessen the probability of its cracking, or splitting the wood. The shank or body of the nail is usually left somewhat rough, so that when driven into the wood it is firmly retained. The head of the nail also offers a greater security against slipping, and it is variously shaped, according to the uses for which the nail is

required. Those called tacks, used for nailing down carpets, &c., are furnished with flat round heads, in order that they may, without cutting, hold the carpet securely; whilst the nails used by carpenters to fasten down the flooring of rooms have small heads that can be readily struck so far into the wood as not to project and cause irregularities on the floor. Nails are generally made by hand, by persons who work with a blacksmith's forge, having the usual description of bellows and hammers, of a larger or smaller size, according to the size of nails to be made.

The persons pursuing this employment, whether men or women, are termed nailors. They use iron which has been rolled at the foundry into thin rods. One end of these rods is heated in the forge, and then hammered on an anvil, whilst still soft, to a point; and the length of rod requisite to form a nail is then cut off, when the rod is immediately placed in the fire to be reheated, during which process the head of the nail cut off is formed by hammering the nail into a hole in a steel instrument called a bore, the hole being the shape of the head required. The making of a nail takes a much less time than the description of the operation. One man has been known to make 17,000 in one week; and the usual number of nails made by one workman in a week is 6000.

The flat nails, called brads, are cut out of sheet iron by the aid of powerful and complicated machinery.

Knife.—Knives or cutting instruments of some description have been used by man from the earliest ages of the world, both for slaughtering animals and cutting up food. &c. The knives at first made were probably of sharp shells, flints, or other hard stones; metals being then unknown. The knives mentioned in the earlier passages of Scripture were probably of this description. (Exod. vi. 25.)

At the present day, knives are almost exclusively made of steel; the maker being termed a cutler. Clasp knives consist of several distinct parts—namely, the blade, the spring, the iron sides, and the scales.

The blade is made out of a rod of steel: one end of this being heated to redness, is hammered to the shape required, and then cut off with the part to form the joint while hot. The small recess called the nail hole, for opening the blade,

is made by means of a chisel of the shape required, which is struck upon it. The blades are hardened by heating them to redness, and plunging them into cold water, and they are afterwards tempered to prevent their being too brittle. The iron sides and the spring are also forged by the workmen. The scales (as they are termed), whether of iron, ivory, mother-of-pearl, or wood, are then taken, and the whole, having been drilled to correspond in the places where the rivets are to pass through, are at first loosely pinned together with bits of wire; and when each part is exactly fitted by filing, &c., the rivets are tightened by hammering. The sides and back of the handle have now to be scraped and polished; this is done on a wheel, somewhat like a grindstone, covered with leather, on which is placed at first sand, and afterwards oil and rotten stone. The blade is lastly ground and polished, and the knife is then fit for use.

The maker's name is usually punched on when the steel is soft. The use of knives depends entirely on the excessive hardness of the steel with which the blades are formed; this allows a very sharp edge to be given to them, which is preserved for some time.

Pin.—This small instrument, from its extensive use, is an important article of manufacture. It is stated that there are made in this country, for home use and exportation, more than 15,000,000 pins daily.

The mode of making pins is as follows. A quantity of brass wire, of the requisite size, is first cleaned by soaking it in dilute oil of vitriol (sulphuric acid) and water; it is then straightened and cut into pieces a little longer than the length of six pins; these pieces are pointed at each end by a person who sits in front of two small, but broad steel wheels, the rims of which are notched like a file, one coarsely, the other finer. Several of the pieces of wire are taken in the hand, and their ends being applied to the wheels, which are turned round with great rapidity, are ground to points. They are first commenced on the coarse wheel, then finished on the fine one.

After both ends of the piece have been pointed, one pin's length is cut off from each end. The ends left are then pointed, and two more pins' lengths cut off, and so on, until

each length is converted into six pointed pieces. The stems of the pins are then complete, and the next step is to form the head. This is effected by winding some small brass wire in a coil round a piece of steel wire, the same size as that of the pins. (The smaller wire is coiled round the larger one in exactly the same manner as the thread is coiled round the wire used for stiffening caps and bonnets.) The coils of small wire are slipped off the large wire, round which they were made, and the workman takes a dozen, or more, coils, and, with a pair of shears, cuts them up into little short pieces of two turns or coils each, and these form the heads of the pins. These heads are then annealed, by being made hot and thrown into water, and are ready to be fixed on the stems. This is done by the workman taking one of the stems, dipping the point of it into a bowl containing the heads, catching one on it and sliding it towards the other end; he then places it on a piece of steel, called a die, containing a hollow the exact shape of half the head, and presses down on the head, four or five times, another similar piece of steel. This operation fastens the head on the stem and gives it the required figure.

The pins are next cleaned, and tinned, by boiling them with a solution of tin. They are then taken out, dried and polished, by being well shaken in a bag with a quantity of bran, which is removed by shaking them in open trays, when the bran flies off, leaving the pins perfectly dry and clean, and ready to be fixed in the papers in which they are sold. Even this last simple operation is done by the aid of machinery.

Putty is the cement used by glaziers for fastening the glass in the frames of windows. It is composed of linseed oil and whiting. The latter is well dried, pounded, and sifted, till it becomes a fine powder, perfectly free from grit; it is then gradually added to the linseed oil, which is warm. These ingredients are well stirred with a stick, till thoroughly mixed together, and, when sufficiently thick, are worked by the hand on a table, and afterwards beaten with a mallet, so as to become a smooth, soft, tenacious mass.

The use of putty depends on the property it possesses of hardening gradually on exposure to the air; after some time it becomes almost as hard as stone.

It is well adapted to the cementing of window frames, as it

not only secures the glass firmly, but perfectly closes the joint, so as to prevent draughts of air entering, or the rain from beating through the window. When used in very exposed situations a small quantity of white lead is added; this has the effect of rendering the putty more durable.

Scissors.—Scissors are a well-known cutting instrument made of iron or steel. The manufacture of scissors consists, first, in the hammering out of the blades from a bar of heated steel; the bow being roughly made by stretching a small hole made in the steel, by hammering it on to a conical anvil. Another workman then files the blades thus roughly forged into a more perfect shape, and bores the hole for the screw; they are then passed to the grinder, who forms the cutting part to its proper shape. The ground blades are then polished by women who rub them with oil and emery powder. After this they are put together by a screw, and fitted so as to work smoothly over one another. The screw is then removed, and the two blades being wrapped closely together with fine wire to prevent their warping, are heated to redness, hardened by sudden cooling, and afterwards tempered. After these operations they again require grinding, so as to bring the edges to a perfect state. Another workman then adjusts the screws, filing the blades so as to make them open and shut easily. The parts which had become black by burning, are polished by very fine emery and oil, and again, for the third time, are ground, and the edges whetted; they are then ready for sale, previously to which the handles are sometimes burnished by rubbing with a hard steel burnisher.

Scissors that have ornamented handles are worked by the file and drill, one pair sometimes occupying a workman many days or even weeks in finishing the design.

The edges of the blades of scissors are not ground sharp like those of a knife, therefore in cutting they bruise or crush much more than that instrument. With thin objects, such as paper, cloth, &c., this is not of importance, but it prevents their being usefully employed in cutting thick substances.

Thimble.—This well-known little instrument is worn on the middle finger of the right hand, by persons sewing, for the purpose of enabling them, easily and readily, to push the

needle through the cloth, and of preventing its head injuring the finger.

It is made so as to suit the shape of the end of the finger, being conical with a rounded head.

The difference in the thimbles used by men is, that they are open at the end. Thimbles are usually made of some metal, and are pitted on the outside with small sunken *dots*, so that the needle should not slip.

They are made out of a single piece of flat thin metal, which is cut or punched into a circular shape, about two inches in diameter; this is then, either by a machine or by a punch and hammer, forced into a hollow mould, or into several moulds, each smaller than the last, by which it acquires somewhat the shape desired. It is then fixed in a lathe, and turned smooth, inside and out, after which the depressions are indented, or pressed in. Thimbles are frequently made of silver, which is, compared with iron, a soft metal, easily worked, and they are often ornamented on the outside with patterns, or initials, engraved or cut in.

WATCHSPRING.—The force employed to turn the key of a watch, in winding it, coils up very tightly a spiral spring, called the mainspring, which is enclosed in a brass box, and is not seen unless the watch be entirely taken to pieces. The force of this spring uncoiling itself, gradually moves the works of the watch.

Both the main and hair spring of watches (the latter being a very small spring used to regulate the movements) are made from steel wire. The workman first hammers it out on an anvil, by which means it is flattened; it is then ground smooth on both sides; hardened by being heated, and cooled quickly; coiled up, and made to preserve its shape by being heated or tempered, as it is termed.

This last heating gives it the blue colour it possesses, and also seems to increase its wonderful elasticity, and at the same time to preserve it from rusting so readily as it otherwise would do.

OBJECTS

DERIVED FROM

THE VEGETABLE KINGDOM.

CORN.

Introduction.—The word corn is used as a general name for various kinds of grain—such as the grain of wheat, of barley, of oats, of rye, of maize, which last is chiefly used in America, and is frequently called Indian corn. Though so many different plants come under the name of corn, there are certain characters or marks by which they may be distinguished, and which we will consider before we proceed to the description of each sort in particular.

There are, likewise, certain words used in describing the culture of corn and its preparation for human food, which we will endeavour to define at once, and thus avoid repetition under each head.

The various corn-plants are only grasses of a larger kind. They are all annual, the whole plant, including the root, dying when the seed is perfected.

The stem of all is hollow, and is generally called straw, but in some places culm. The inside of this hollow stem is divided by partitions, which form joints, one use of this structure is evidently to strengthen the stem; from these joints or knots the leaves grow; embracing or forming a sheath to the stem for some distance. The leaves are all long and taper, and the veins run straight and parallel with one another from the base to the termination, instead of branching out, and uniting again so as to form a network, as is the case in most leaves.

The blossoms of corn-plants are collected into a head, or

ear, or spike, and are not coloured like the flowers of most plants. Those parts of the flower which, in most other plants, are large and coloured, are in these small and scale-like. When separated from the grain after the corn is ripe, these parts are called the chaff or husk.

The difference between corn-plants and the grasses is merely in size. The seeds of all grasses might be used as food, if they were large enough to make it worth while to collect them for that purpose; no grass-plants, with the exception of one (the common darnel grass), being unwholesome.

The cultivation of the soil is called agriculture, from *ager*, a field, and *cultura*, culture.

The measure generally used to express the size of fields, &c. is called an acre, and a field is said to consist of so many acres.

The first operation necessary in agriculture is that of breaking up the ground by means of a plough; this is called ploughing. The earth, when broken up, generally requires to be mixed with other substances (in order to increase its power of nourishing the seed), varying according to the nature of the soil. These substances (which are sometimes bone, sometimes lime, or fish, or seaweed, &c.) are classed under the word manure; and the process of mixing them with the soil is called manuring the land. When the land is properly prepared, the seed-corn is sown.

This is done in one of two ways according to circumstances. In one, the sower takes a handful, and scatters the seed on the surface of the ground by swinging his arm in a circular direction, while he opens his hand at the same time. This is called *sowing broadcast*. The second method is to make holes in straight rows, into each of which seed is dropped. This is called drilling or dibbling, and is, in most cases, preferable to the first method; but in some soils it cannot be adopted. Each seed produces more than one stalk; the grain is then said to *tiller*.

The growing plants produced in a field, thus prepared and sown, are called the *crop*.

When ripe, the crop is cut down; this is called reaping.

The grain is beaten out from the husk by a process called threshing.

The grain is then separated from the particles of husk with

which it is mixed, by means of a current of air strongly forced upon it. The chaff, being light, is blown away; the grain, being heavy, remains; this is called winnowing.

The grain, thus cleaned, is next measured out in bushel measures. The number of bushels is then divided by the number of acres of land on which the corn grew, and the produce is said to be *so many bushels an acre.*

Grain is sometimes used without any other preparation than cleaning it; sometimes reduced to a mealy powder, called flour, according to the purposes for which it is required. The grain is ground in mills to reduce it to flour; and in the same mill, the flour or mealy portion is separated from the outer skin, which is called bran.

WHEAT.—Wheat is the most esteemed of all kinds of corn, and, where it can be cultivated, and the people are not too poor to use it, is invariably preferred as food. In this country, two kinds of wheat are cultivated, and they are called, from the seasons in which they are sown, spring or summer wheat, and winter or Lammas wheat.

Spring wheat is a much more delicate plant than winter wheat. The ear is more slender, and is readily known by being provided with long awns or beards. Its grain is smaller, and it is less productive; therefore it is seldom sown by the farmer, unless the winter crop fails, or the land cannot be got ready in time to sow the winter kind.

It is not uncommon, in the case of a failure in a crop of winter wheat, to sow the spring wheat in April or May; as it may be depended on for producing a fair return in the following autumn. Sometimes, patches of spring wheat are sown amongst the winter kind, where the latter has partially failed. If this is done about the commencement of April, both kinds will ripen at the same time.

Winter wheat is a more vigorous plant, and it is destitute of the long awn or beard. Some varieties of winter wheat are redder than others; hence we hear of red and white wheat.

Wheat is most commonly sown broadcast, though, of late years, the practice of dibbling has been introduced to a considerable extent.

Wheat plants tiller very freely; the usual number of stalks arising from one grain is five, but sometimes many more.

The produce of wheat at the present time is about 24 to 28 bushels an acre. In those counties where manure is cheap and agriculture carried to a high state of perfection, a much larger quantity is produced. In Middlesex, for example, upwards of 40 bushels are not unfrequent from a single acre.

From every 12 bushels of wheat one load of straw is usually obtained, which is made up into 36 parts, called trusses. The weight of a bushel of wheat is usually 60 pounds. This, on being ground, yields

Bread-flour	47	pounds
Pollard . . .	8	"
Bran	3	"
Loss in grinding	2	"
Total . .	60	

Barley.—Barley is more cultivated in this country than any corn, except wheat; for, although bread is not now made of it, as formerly, it is used very extensively for the making of fermented and spirituous liquors.

Barley is a much more hardy grain than wheat. It comes more quickly to maturity, and in short dry summers ripens perfectly when the other grains do not. In Spain and the Eastern countries, two harvests of barley are collected each year. This fact explains a passage in Exodus (ix. 31), where the plague of hail is mentioned—"The flax and the barley were smitten: for the barley was in the ear." . . "But the wheat and the rye were not smitten; for they were not come up." This event happened in March; the first crop of barley was, therefore, nearly ripe, being sown the previous autumn; but the wheat and the rye were not sufficiently advanced in growth to be injured by the hail.

In this country, barley is usually sown in the spring, and reaped the following autumn. It thrives best in dry seasons. If there be much wet, it becomes sickly; and in very wet seasons, the grains contained in the ear will sprout while the plant is yet in the ground; so that each ear resembles in appearance a tuft of grass.

Clover is often sown with barley; the two crops growing at the same time.

The quantity of barley produced on an acre of land is from 35 to 50 bushels.

The shape of a grain of barley is well known; and from its tolerably uniform length, it has given name to one of our divisions of the inch—namely, the third; it being reckoned that three barleycorns, placed end to end, make an inch.

Each grain of barley ends in a long awn or beard, which is broken off in threshing. The uses to which barley is applied in this country, are chiefly for the formation of beer and spirit. Some portion, however, is formed into *pearl barley,* by grinding off the outer husk in mills adapted to that purpose.

Barley is also used as food for poultry, and, when ground into meal, for fattening pigs.

At times, when wheat is dear, the labouring classes in the country mix barley flour with their wheat flour to make a cheaper kind of bread; but this food is by no means a favourite with them; as it is coarse, dry, and apt to become sour.

The large quantity of 30,000,000 bushels of barley is yearly consumed in this country in brewing beer, for which it is prepared by a process called malting, or converting it into malt. This is performed by first steeping the barley in water until it has become soft and swollen. It is then taken out to drain, and allowed to lie in heaps for forty hours; during which time each grain begins to grow, as it would if planted in the moist earth. To check the growth, the barley is then turned and spread out for some days; then heaped together again, and afterwards dried, by being spread out, on a wire or hair cloth, over a kiln; and as it is more or less dried, the colour is dark or light brown, and the malt is used for brewing porter or pale ale.

In malting, barley undergoes the change which all seeds do in beginning to grow. The starch of the seed is converted into sugar; hence the taste of malt is sweet, and the liquor which is afterwards made into beer, and has a bitter taste in consequence of the hops having been added to it, is, in the first instance, when the malt only has been boiled in water, extremely sweet, and in that state is called *sweet* wort.

Oats.—This grain is much more grown in northern than in southern countries; the oats of the south of England being very inferior to those of Scotland. In appearance, this corn

differs much from wheat and barley; the grains are not arranged in a close ear, but form a loose cluster around the stem.

This corn possesses the very great advantage of growing in places too cold and exposed for wheat or barley; in dry and hot seasons, it does not flourish, as the grain becomes husky, and contains little nourishment.

Oats are sown by broadcast, in March or April; about 50 or 60 bushels are the usual produce of an acre.

There are several kinds of oats—some are dark in colour, others light; some have an awn or beard, while others are destitute of such an appendage.

Oats are by no means so nutritious a corn as wheat, or even barley; formerly they were used in the preparation of intoxicating drinks. In the southern parts of the kingdom, oats are chiefly used as food for horses, and in fattening poultry. Coarsely ground, they are called groats, (a contraction probably of ground oats) and are much used for making gruel. In Scotland, oats are largely used as human food, both in the form of porridge and made into oaten cakes. These are much eaten in Lancashire also. Although not so nutritious as wheat, oats are an extremely wholesome article of food.

Rice.—Unlike most corn plants, the native country of rice may be fixed with certainty, it is, undoubtedly, a production of the warmer regions of Asia, in some parts of which it is now found growing wild, and the seed is collected for use. From hence it has been carried by man over the greater part of Asia, part of Europe, and the continent of America, where it is now cultivated in immense quantities; it was introduced there about 150 years since. In appearance, the stalk and plant of rice may be said to resemble wheat, but the grain is bearded, and not arranged in a close ear. In fertility and abundance of produce, it much exceeds our English grains. In India they raise two crops a year of 30 to 60 bushels each, the ordinary produce of an acre. The great peculiarity in the culture of rice is the large quantity of water it requires. In America, for instance, it is sown in the spring, in rows or trenches about 18 inches apart, and the ground is then flooded for some days; again, when the plant is but a few inches high, the water is allowed to flow over the land and remain for a fortnight; and a third time, shortly before the grain ripens, the

fields are again flooded, and remain so until the harvest. From the swampy condition in which the soil is kept, the cultivation of rice is a most unhealthy occupation, and, in America, it is left almost entirely to the care of the slaves, their masters frequently leaving the province during the time. Rice is grown in much the same manner in Italy; and also to an immense extent in the island of Ceylon, China, and India. In all these countries, the best rice fields are the low open grounds through which large rivers pass; in other situations, the waters of the small streams are caused to flow into artificial reservoirs, which are used for watering the grounds. On the grain becoming ripe, the water is drained off, and the corn reaped with a sickle, the labourer being frequently knee-deep in the soft mud in which it grows.

No grain supports the life of so large a number of persons as rice. The inhabitants of China, India, and a large portion of America, live chiefly upon it. In the south of India it forms, with a few spices called curry, the whole food of an immense number of the inhabitants, and even the resident Europeans eat it with every meal. Rice consists almost entirely of starch; hence it cannot with advantage be baked into bread, as the dough is not tough enough to rise. It is, however, light, wholesome, and easily digested. Rice is brought into this country in two forms: in the brownish husk, in which state it is called Paddy or Paddee, and with the husk ground off; formerly, the separating the husk was chiefly performed in India, by beating the rice in large earthen or stone mortars: it is now done by machinery taken from this country. But, at the present time, very large quantities of unhusked rice or paddee are brought to England; it is found that, from being protected by the husk, the grain is less injured in the passage; and it is more perfectly cleared by the superior machines of this country.

Although rice is not spoken of by name in the Holy Scriptures, it must have been known to the Sacred Historians, and it is most probable that its cultivation is alluded to in Eccl. xi. 1, and Isa. xxxii. 20.

SPICES.

The spices are vegetable substances which, from their aromatic, pungent, stimulating qualities, and, in most cases, agreeable taste and odour, are used for flavouring food, and also to assist in preserving it. Taken in small quantities they are not unwholesome, as they assist digestion; in large quantities they are extremely hurtful.

The spices are all foreign productions, procured from tropical climates, chiefly the East and West Indies: not any of the plants that produce them will bear the cold of our climate.

Allspice.—This spice is also named Pimento, and sometimes Jamaica Pepper, from the island whence it is chiefly obtained; it is the berry of a tree somewhat resembling the myrtle in appearance. It grows to the height of 30 feet, the trunk being smooth, and much branched towards the top; the branches are thickly covered with a large number of shining evergreen leaves, which resemble, in size and appearance, those of the sweet bay. In July and August the trees are covered with a great number of small white flowers, contrasting beautifully with the dark green leaves, whilst the whole tree sends forth a rich, fragrant perfume. The allspice tree is chiefly grown in the island of Jamaica; it is there cultivated largely for the sake of its fruit, which is the berry we use as spice. These are plucked by hand before they are ripe, and dried in the sun until the seeds rattle inside when shaken. During the drying, the berries change in colour from green to a reddish brown. If they are allowed to become ripe on the tree, they turn purple, and when dried are found to have lost their aromatic odour and flavour, and are useless as spices. The name of allspice is given to them because their taste and smell resemble that of a mixture of cinnamon, cloves, and nutmegs.

Cinnamon.—This spice is the inner bark of a tree closely resembling the laurel, or sweet bay, a native originally of Ceylon, but which is now grown in the other parts of the East Indies, and also in Jamaica and other islands of the West Indies. The trees are usually left to grow unmolested until they are nine years old, at which time the young shoots, or branches, that are about three years old, are lopped off. The bark is then slit up on one side and removed from the branch, tied up in bundles until the next day, when it is loosened, and the skin or outer bark scraped off. It is then dried or rolled up into quills or pipes, about three feet long, which have a slit down one side where the bark was cut. The smallest quills are rolled up inside the larger; the whole are then tied up in bundles of 80 or 90 lbs. weight, and wrapped up in cloths, when they are ready for exportation.

Cloves.—Cloves are the unopened flowers of a small evergreen tree that resembles in appearance the laurel or the bay; it is a native of the Molucca, or Spice Islands, but has been carried to all the warmer parts of the world, and is now largely cultivated in the tropical regions of America. The flowers are small in size, and grow in large numbers in clusters at the very ends of the branches. The cloves we use are the flowers gathered before they have opened, and whilst they are still green. After being gathered they are smoked by a wood fire, and then dried in the sun. Each clove consists of two parts, a round head, which is the four petals or leaves of the flower rolled up, enclosing a number of small stalks or filaments. The other part of the clove is terminated with four points, and is, in fact, the flower-cup, and the unripe seed-vessel. All these parts may be distinctly shown if a few cloves are soaked for a short time in hot water, when the leaves of the flowers soften, and readily unroll. The smell of cloves is very strong and aromatic, but not unpleasant; their taste, when unmixed with other substances, is pungent, acrid, and lasting. Both the taste and smell of cloves depend on the quantity of oil they contain: this is so great, that it may be pressed out with the finger. Sometimes the oil is separated from the cloves before they are sold, and the odour and taste in consequence much weakened by such unfair proceeding.

GINGER.—This spice is the produce of a plant growing in both the East and West Indies. In its appearance it somewhat resembles a reed, or sedge, but the stems arise from a root of exactly the same kind as the root of the sweet flag, or iris, that is so commonly grown in our gardens.* Like the root of this flower, that of the ginger-plant spreads and increases in size every year. From the upper surface of this root arises, in the spring, a green reed-like stalk, about two feet and a half high, which bears narrow lance-shaped leaves. The flowers of the plant, which are white and lilac, grow on a separate stem. The ginger we employ as a spice is the root, to obtain which the plant is cultivated in much the same manner as potatoes are, and when the stalks have withered, the roots are dug up. The best and soundest of them are selected, scraped quite clean, and carefully dried in the sun, when they are ready for exportation and use. The inferior roots are scalded in boiling water instead of being scraped; and these when dried form what is called black ginger, a very inferior kind. The colour of black ginger, as it is termed, is yellowish grey on the outside, and orange brown within; in shape it is thick and knotty. The best, or white ginger, being scraped in preparing it, is less in size, not being so thick or knotty; its colour is a light yellow, and its taste is much more pungent and aromatic than that of the black kind.

NUTMEGS and MACE.—These two spices are the produce of one tree, which is a native of the East Indies. The tree is not of large dimensions. Its fruit is of the same size as a peach; the outer rind, which resembles somewhat the green rind of a walnut (although it is much thicker), is smooth, pulpy, and bitter, and about half an inch thick. As the fruit ripens, this outside covering bursts, and discloses a thin bright scarlet membrane, which appears as if torn into narrow branched slips. This membrane, when dried, is mace. It grows round the nut, which consists of a thin, hard, dark-brown shell, enclosing an oily kernel, which is the nutmeg. The nutmeg-tree is largely cultivated for the sake of these

* This part is not, strictly speaking, the root of the plant, but a kind of underground stem; the true roots, which consist of fibres, grow from its under surface, and penetrate the ground.

spiees. The fruit is gathered when ripe, the outer rind taken off, and thrown away. The maee is then earefully separated from the nut and dried. During the operation it loses its bright searlet, and beeomes of a reddish orange eolour. It is then pressed into bags, and is ready for exportation. Maee, when good, is of a rather deep eolour, very oily, with an agreeable aromatie odour, and a similar, though somewhat bitter taste. After the maee has been removed, the nuts are dried, first in the sun, and then over a fire, until the kernel has so shrunk as to rattle in the shell when shaken. The latter is then broken, and the kernels, whieh are the nutmegs, extraeted. These are dipped in lime and water to preserve them , and exported.

WOODS.

Introduction.—On examining the stem or trunk of any tree, that is a native of temperate climates, we find it consists of three distinct substances. In the centre is situated a light, soft, and porous, or cellular body, called pith, which is so large in the elder that it may be readily examined. The use of the pith appears to be to convey the sap upwards to the leaves when the plant is very young, and before any other channels are formed for its ascent; as the plant increases in age the pith becomes dry, and is, apparently, of no further use, and may be removed without any injury to the life or health of the tree. Surrounding the pith is the wood, which consists of tough, strong fibres, so closely united as to form a very firm solid substance. The fibres are placed side by side, and run in the direction of the trunk; they cause what is termed the grain of the wood, and when we cut a piece of wood *across* the *grain* we cut these fibres across; when we split it *with* the grain we merely tear the fibres apart that were before lying side by side. Every summer the tree forms a fresh quantity of wood around that of a previous growth; therefore it of necessity makes a circle, and on attentive examination of the trunk when cut across, we may perceive that the whole mass of wood consists of a number of circles in succession; each of these circles has been the growth of one year, and by counting them we ascertain the age of the tree. The wood that was formed the first year is next the pith; that formed the second year of the tree's life is outside the wood of the first year, and so on a fresh circle is deposited every year outside those previously formed; hence the oldest, and usually the firmest wood in a tree is the centre, and this is called heart wood; whilst the youngest and softest is on the outside, and is called

the sap wood, as it is through it that the sap rises to supply the branches and leaves. The uses of the wood to the plant are twofold: it gives great firmness and strength to the stem, enabling it to bear up the head of the tree and to withstand the force of the wind blowing against it; it is also the channel through which the sap rises from the roots to be conveyed to the leaves and flowers. The uses of wood to man are immense, but they will be spoken of as each particular wood is described. On the outside of the wood, protecting it, and serving also as a channel for the descent of the sap, is the bark, which is more partieularly described under the head of Oak Bark.

Cedar-wood.—The cedar-wood used in this country at the present time is not, as its name would lead us to suppose, the produce of the cedar tree, but of a kind of juniper, a native of the Island of Bermuda; the tree is too tender to grow in the cold climate of this country; like our common juniper, it has long, narrow, sharp-pointed leaves, and its seeds, instead of being contained in a cone, like those of the real cedar, are enclosed in a small fleshy berry.

The tree attains a very large size, and the wood is sent to this and other European countries in considerable quantities. It is of a very fine close grain, but, at the same time, exceedingly soft and light. Its odour is agreeable and fragrant, and its colour a delicate slightly reddish brown. It is occasionally used by cabinet makers, but it is too soft for most purposes, being readily scratched by the nail. Its great use is for making pencils and pen-holders; to these purposes it is well adapted, by its lightness, and by the readiness with which it is cut, as well as by its agreeable colour and smell. It is occasionally used in the form of shavings to drive away moths; but a stronger odour, as camphor, is much more efficaeious.

Mahogany.—The tree that yields this valuable wood is a native of the West India Islands, and the central and warmer parts of America.

The tree is tall and straight, often rising to a great height before it branches out; it frequently measures above 100 feet to the top of the branches. The latter spread out on every

side to a great extent, forming a very large head; the leaves are a deep shining green, and somewhat resemble those of the walnut; the flowers are small and whitish, their pearly appearance contrasting very beautifully with the deep colour of the foliage. The age which the tree attains is great, as it grows but very slowly—most probably it does not arrive at maturity under 200 years. The trees, when felled, are hewn into a square shape before shipped to this and other countries.

The wood yielded by the tree is of great value to the cabinet maker, partly, from its great hardness, which renders it not so liable as other woods to be scratched, and enables it to take a fine polish. It is also valuable from its remaining straight when made into articles of furniture, it not being liable to warp or bend Its colour, also, is dark and rich, especially when it is oiled or varnished, and it also readily receives a polish.

These desirable qualities have brought this wood into almost universal use as a material for furniture, and there are but few houses in this country which do not contain some article made of mahogany, though it is a native of so far distant a climate. When first discovered the wood was used for building or repairing ships by the Spaniards; but its beauty being observed, it came rapidly into its present use.

The bark of the tree has been used in medicine; but, though very astringent and bitter, its value is not equal to that of other barks more employed.

Oak-wood.—Oak-wood is the produce of several varieties of oak growing in different parts of the world. It is also yielded of a most excellent quality by the two kinds of oak which are natives of this country.

The wood is of a coarse, open grain, but, at the same time, heavy, and exceedingly strong and tough. Hence it is of great value for all purposes where strength is required—as, for example, for spokes of wheels, the bars of ladders, and the frame-work of machinery; builders requiring wooden bars of great strength for roofs, &c. of large buildings, as cathedrals, usually employ oak, as there is not any wood so readily obtained that possesses its strength or durability; many of the roofs formed of it have lasted even hundreds of years. Oak resists the action both of air and water, and it is owing to

this property, as well as to its strength, that it is employed in building ships of war—for which purpose it is well suited, by the power it possesses of permitting a cannon ball to pass through it without its splintering, so as to form a large aperture. The crooked branches of the tree also yield what are termed knees, these are the bent timbers placed inside the vessel to support the decks, and to strengthen the hull.

As the oak is not affected by moisture, it is generally employed for making tubs, casks, and pails, for which purpose its great strength also renders it servicable.

Pine, or Fir-wood.—The different kinds of fir-wood, pine, or deal, are all the produce of various species of fir trees. Thus the scotch pine, or fir, yields the red deal, used by carpenters, &c.; and the yellow deal, white deal, and pine are the produce of other fir trees.

All the various kinds of fir-wood are valuable, but none more so than the Scotch fir. The value of these woods depends on several circumstances; the trees being tall and straight yield planks which are long and free from knots. The wood is also light and soft, so as to be readily worked by the carpenter or builder, and, at the same time, sufficiently strong to form beams and joists for houses, frame-work for machinery, &c.

It is from its holding glue better than most other woods, and being so readily worked, that it is selected by the picture-frame carver, and by the cabinet maker; who, after that he has formed articles of furniture from it, covers them with a thin coating of mahogany, or rosewood, called veneer, which is glued on.

The various kinds of deal are valuable from their power of resisting decay; this is perhaps owing to the quantity of turpentine and resin that they contain. The wood seems saturated with these substances; and as they are not acted upon by water, they must serve to protect the wood from damp; so well is this known, that builders always cause the piles on which bridges are raised to be made of fir. The straightness, lightness, and strength combined in this timber, cause it to be used for forming masts, yards, &c. to ships. It is fortunate for man that a wood so valuable should be abundant; we find, in the mountainous districts of all countries, pines in immense forests, from the coldest regions of Norway and

Sweden, to the warm climate of the Holy Land ("Solomon got cedar trees, and fir trees, according to all his desire"); so that the wood most generally useful is the most easily obtained, and though in quality the most valuable, in price the least.

MISCELLANEOUS SUBSTANCES.

Acorn.—An acorn is the fruit, or ripe seed vessel, of the oak. It consists of a hard cup formed of small scales firmly connected together, and an oval nut, which is joined at its base to the cup. The nut has a thin, light brown shell, which encloses the kernel, or seed. Before the acorn has become ripe the cup entirely covers the nut, which it preserves from injury. As the nut grows its shell becomes hard, and it no longer requires the protection of the cup, from which it bursts forth.

The only use to which acorns are applied at the present time in this country is for the food of pigs. When the acorns are ripe they fall from the oaks, and the swine are driven into the forest and eat them. The bacon and hams of the Hampshire pigs, which feed in the New Forest, are considered particularly excellent.

Before the birth of our Saviour the original inhabitants of this country (the Ancient Britons) made acorns a large part of their food; and even now the inhabitants of Spain and Portugal eat the acorns which grow on differant kinds of oaks; they are, however, much less bitter than our acorns, and are really good food.

The squirrel, and other small quadrupeds, and some of our wild birds, feed largely on acorns.

The mode in which a plant bursts forth from its seed may be most beautifully and instructively shown by partially filling a hyacinth glass with water, fitting a card to the top, as a kind of lid, and from the card suspending an acorn *over* the surface of the water. After a few weeks the acorn begins to sprout, or germinate, and when some time has elapsed a hole must be made in the card for the little tree to shoot through. This experiment should be performed in the autumn, when the

acorns are fresh from the trees; and if the glass be kept in a warm room the plant will live through the winter: it dies however in the spring, if not planted in the earth.

Beans, dried.—Beans are the produce of a plant originally a native of the East, but now cultivated, very generally, over the more temperate parts of the world.

The plant is an annual, about two feet in height, bearing divided leaves on a short stem; its flowers are butterfly shaped, and when they fall off are succeeded by that kind of fruit called a pod, consisting of two halves readily divided, each having on its lower edge several seeds, or beans.

If a dried bean be soaked in water for some days, and then examined, it will be found to consist of a thick skin, enclosing two parts, or halves, called the seed lobes, or leaves, connected together by a small curved body, pointed at each end.

When a bean is sown it absorbs moisture from the ground; every part swelling, the skin bursts, and one point of the connecting body between the lobes shoots up into a stem, whilst the opposite one grows downwards into the root; these, until they are able to procure food for themselves from the ground, are nourished from the fleshy seed lobes which, during this time, are forced above ground by the growth of the young stem, and, turning green, act as the first leaves of the young plant; afterwards, when the other leaves are grown, these are no longer required, when they dry up and fall off. For agricultural purposes beans are sown by the drilling machine, or dibbled in with the hand, four or five being placed in each of the holes, which are made from six to eight inches apart. They are planted about the end of February, and cut down in autumn.

The great use of beans is in feeding horses, for which purpose they are split, or crushed, and mixed with cut hay, or chaff. As they contain a very large amount of nourishment they are employed as food to fatten hogs for bacon, sometimes being used whole, at others ground. Millers also grind them with new wheat to make bread flower; and, in some parts of the country, a large quantity of bean meal is used in the coarser kind of bread.

The broad Windsor beans, used, when green, as a table vegetable, are merely a large kind of horse bean, improved by cultivation.

Beer.—Beer is an intoxicating and spirituous liquor, manufactured from malted barley and hops. The malt is first crushed or ground, and then soaked or mashed in hot water: after the water has dissolved the sugar and other substances of the malt, it is drained off (and in this state it is called sweet wort, from its sweet taste). It is then boiled with the hops, which give to the liquor their strong bitter taste. After being strained the hops, the liquor is cooled as rapidly as possible, and is then placed in a large vessel or fermenting tun, along with the requisite quantity of yeast, which has the power of causing it to ferment in a short time.

During this process the sugar that existed in the malt is converted into spirit, whilst the bitter of the hops remains nearly unchanged.

It is a common error to suppose that beer does not contain spirit, this is incorrect; the spirit in beer is of the same nature as that of distilled liquors, the only difference being that in beer it is much smaller in quantity and mixed with other substances, as the bitter of the hops and the various substances dissolved out of the malt.

Beer, as thus made, is of variable colour, from pale amber to dark brown, depending on the kind of malt used. If the malt be much dried in the making, it gives a very deep colour to the beer, which is then called porter; if, on the contrary, it has been slightly dried, the beer is pale.

With regard to the usefulness of beer when taken as a drink, even in moderation, there is great difference of opinion; but there is no doubt that when taken in large quantities continually, it produces a bloated irritable state of the body, and that it also stupifies the intellect and deadens the faculties of the mind.

Bran.—On grinding wheat to form flour, the brown skin covering each grain of corn is broken up into small pieces, forming what is called bran. By sifting the ground corn or meal, this bran is separated from the flour and preserved for use.

It consists of small scales, and is used for feeding animals, as rabbits, pigs, and even horses occasionally. As it is very light, it makes a good stuffing for dolls, pincushions, and

small objects, and is used by calico printers in the process of dyeing cloth.

Chamomile Flowers.—Chamomile flowers are the produce of a plant common in many parts of England. It is a dwarf plant, with very finely cut or divided leaves; each flower head consists of a yellow centre surrounded by white leaves in the form of rays. All parts of the plant are intensely bitter and nauseous to the taste, especially the flowers, which have a rather agreeable aromatic odour. On account of possessing these bitter tonic properties, chamomiles are used as medicine, and are cultivated extensively; the flowers are picked and dried in the sun.

When growing wild, chamomile should not be confounded with the mayweed, a plant to which it bears a great resemblance; but which is distinguished readily by its erect branching stem, and very disagreeable and powerful odour.

Camphor.—Camphor is a vegetable substance, in appearance semi-transparent and colourless; solid, and easily broken, and yet at the same time so very tough that it is with great difficulty it can be powdered, without the addition of a few drops of spirit or oil.

It is exceedingly volatile, and when exposed to the air it flies off in vapour.

Its smell is very strong and aromatic, and not easily mistaken if once known. On account of this strong odour it is much used to preserve cabinets and clothes from insects and moths; it does not destroy them, but is so much disliked by them, that they will not frequent the situations where it is placed.

From its strong smell also has arisen the idea that it will prevent the catching of infectious disorders, and it is frequently carried by persons under this supposition; it is, however, much more hurtful than beneficial, as its effect on the system, though at first stimulating, becomes depressing, leading to slight headache and oppressed breathing, thereby rendering the disease feared much more liable to be taken.

Camphor dissolves in water only in very small quantity, sufficient however is taken up to give to the water both its aromatic odour and bitter taste. Water containing a small

quantity of camphor dissolved in it, is known by the name of camphor julep.

A singular effect takes place if some very small shavings of camphor are thrown on the surface of *perfectly clean* water contained in a large basin; the pieces of camphor immediately begin to move rapidly, some turning round on their centre, and others moving from place to place: the cause of these motions is unknown.

Camphor is readily dissolved by spirits of wine: the solution thus made is called camphorated spirit; it is useful for rubbing unbroken chilblains, and for applying to burns and scalds when the skin is *not destroyed* or broken.

As a subject of an experimental object lesson, camphor is well adapted to develop several ideas; for instance, a small portion placed in water will show its sparing solubility. Another portion may be dissolved in spirit of any kind. If first coarsely powdered, its fusibility and volatility may be strikingly exemplified by placing a small piece in a spoon, and holding it over the flame of a candle. It first melts, and then rapidly volatilizes; and if allowed to come in contact with the flame, its inflammability is easily shown.

Camphor exists in many plants, but it is obtained chiefly from two trees; one a native of China and Japan, very much resembling the laurel. From this tree it is procured by chopping up the leaves, branches, root, &c. into small pieces, and placing them in a still with water; on the bottom of the still being heated, the camphor, from its volatility, rises in vapour, and collects again in a cold part of the apparatus. When brought to Europe, it is purified by a second distillation. The other tree from which camphor is procured is a native of Borneo and Sumatra; the camphor is obtained by splitting open the tree, when it is found in large pieces in the interior.

Cane.—Canes, or ratans, are the long slender shoots of a prickly plant which grows wild, in immense numbers, in the forests of the Malay peninsula, and the Eastern Islands, as Borneo, Sumatra, &c. The stems are cut by the natives, stripped of the outer skin by being pulled through a notch cut in a tree, and tied up in bundles of 100, being bent in the middle and the ends fastened together.

In this form they are exported in immense numbers to

various parts of India, China, and Europe; to England alone many millions of ratans being brought annually. If a cane be examined, it will be found to consist of tough wood fibres, among which are a number of open tubes, which allow the sap to ascend with sufficient rapidity to supply the great evaporation that takes place from the leaves in tropical climates. On the outside the cane is covered with a transparent glazing, of extreme hardness, so that when two pieces are rapidly and forcibly struck together fire is produced.

For use, those canes are regarded as the best which are thin, very long, of a pale yellow colour, and so flexible as to bend without breaking or cracking the glazing.

The chief use to which they are applied in this country is, in forming the open lattice, or cane-work used for the seats of chairs, and similar purposes. When employed for this purpose they are split into slender slips, the glaze being retained. These slips are woven, by hand, into the open work, which is well adapted to resist pressure, from the great strength of the material; whilst the extreme hardness of the glazing, which is placed on the side exposed renders it very durable.

Chaff.—Chaff consists of hay, dried clover, straw, or a mixture of these, cut small by means of a machine called a chaff-cutter. It is used as food for horses, being generally mixed with the corn that is given to them.

This name is also given to the husks of corn that are detached from the grain by threshing, and afterwards separated by winnowing. It is in this sense that the word is used in the Scriptures. The chaff of grain is used for stuffing common beds, and it is also thrown down in farm-yards for litter.

Coffee—raw and roasted.—Coffee is the seed of a small evergreen tree, or shrub, which grows to a height of sixteen or twenty feet. It is a native of Arabia and Abyssinia, but is now grown in very great quantities in the East and West Indies.

The evergreen leaves of the shrub are of a bright colour, and resemble, somewhat, in shape and size, those of the bay. The flowers are like the jasmine, and are brilliantly white; they open so rapidly, and are in such great abundance, that

the trees at the time of flowering appear as if covered with snow, and at the same time emit a most delicious fragrance. Each flower is succeeded by a small berry, which attains the size of a cherry, and becomes, when ripe, of a dark red colour; it contains two seeds.

In Arabia the berries are gathered by placing cloth under the trees and shaking the branches, when the ripe ones fall off; they are then spread on mats and dried in the sun, and the husk removed by being crushed with a large stone roller. After this the seeds are again dried in the sun, and packed up in bales for exportation.

In the West Indies, as soon as the fruit is of a deep red colour, it is gathered by the negroes, who pick the ripe berries with their hands and put them into large bags hung about their necks. The berries are then either placed in the sun, in layers, about four inches thick, when the pulp ferments, and dries in about three weeks; or they are at once crushed in a mill, which bruises the pulp; but not the seed, the former is then washed away, and the coffee dried.

Coffee, of which the beverage so called is made, is the seed of the berries. The form of the seed is convex or curved on one side, and flat on the other; the latter being deeply grooved. In this raw state it is of a pale brownish yellow, and has but little taste or smell. When roasted in a close iron vessel, placed over a slow fire, it acquires a dark chesnut colour, and each seed increases very much in size; from being nearly tasteless and inodorous, it becomes bitter and crisp, and gives out a powerful aromatic smell.

This roasted coffee is made into a beverage by infusing it in boiling water, or by boiling it. When the latter mode is employed, care should be taken to boil it a very short time, for if long on the fire the aromatic flavour is dissipated, and the bitter principle alone remains.

Coffee is a stimulant, and a preventive of sleep; if made very strong, and taken at night, as it frequently is by persons engaged in literary pursuits, it retards the accession of sleep for several hours.

Cork.—Cork is the bark of an evergreen oak, which grows abundantly in Spain, Portugal, and the south of France.

In order to remove the cork, a long cut is made down the

tree, at the two ends of which, incisions are made round the tree; the bark is then removed by an instrument inserted under it. If the operation is carefully performed, the cork tree is not injured, as the part of the bark which is taken is really dead; but the inner bark cannot be removed without killing the tree.

The cork is first taken from the tree when it is about fifteen years old, and the operation is repeated every eight or ten years, as long as the tree lives, which is usually about 150 years.

After the cork bark is taken from the tree it is slightly charred, or burnt. This improves it, by closing the pores; but at the same time blackens it, and gives it a burnt odour, which it sometimes communicates to the liquors with which it comes in contact. After being pressed flat, it is tied up in bundles and exported.

Cork possesses several qualities that render it very valuable. It is extremely light, hence it is used to float other bodies in water; as when used as floats to fishing-nets; for cork jackets to support persons in the water; and also for life-boats.

Cork is extremely compressible and elastic. These qualities fit it admirably for stopping the mouths of bottles containing fluids; as, when pressed firmly in, its elasticity causes it to press so closely on all the parts of the mouth as to prevent the contents of the bottle from escaping, or the air from entering. Cork is also used to form the inner soles of shoes and boots; whilst it keeps out the wet, it adds little to the weight.

Cork is brought to this country in an unmanufactured state, and is cut into the shapes and sizes required, by men called cork-cutters; the knives they use are extremely sharp, and require to be frequently whetted.

Currants.—The foreign, or grocers' currants are small raisins, or dried grapes, which are grown, principally in the Grecian Islands. The name of currant has probably been given them from the resemblance, in size, to our common English fruit of that name. They are destitute of stones, and of a dark reddish-black colour. When first gathered their flavour is extremely delicious.

These small grapes are gathered from the vines in August,

and spread out on earth which has been stamped hard, and left until the sun has dried them, when they are closely pressed into warehouses, where they remain until they are dug out and packed in casks for exportation.

They are so much used for various purposes, that above 6,000 tons are annually imported into this country.

FIG.—This fruit is the produce of the fig-tree, a plant originally a native of the south-west of Asia, but which is now also cultivated abundantly in all the countries in the south of Europe.

The tree is of small size, and bears a large leaf, which is so deeply notched as to be partially divided into several lobes. there are not any visible flowers, but the fruit arises from the stem, in the form of little buds; these are pear-shaped, and appear to be pierced at the large end with a small hole. They continue to enlarge in size till they become the ripe fruit, retaining their original pear-like shape.

If one of the unripe buds be cut open it will be found to be hollow, and the inside to be covered with numerous small points; these are the real flowers, which are thus enclosed in the fruit. Before it is ripe the fig abounds with a bitter milky juice; in the ripe fruit this is converted into sugar.

The tree is easily cultivated in this country, if protected from severe cold; but its green fruit is not much valued, as it does not arrive at perfection in our climate.

In the East figs are a most important article of food, both in their fresh and dried state.

One of the most valuable qualities of the plant is its bearing ripe fruit three times in the year.

In the Scriptures we find frequent allusions to its utility. The Old Testament contains many passages respecting the value set on it; and the failure of the crop was regarded by the Jews, as a very serious calamity. We find its treble crop of fruit alluded to. Hosea says, "I found Israel like grapes in the wilderness; I saw your fathers as the first ripe in the fig tree at her first time."

In the Levant, from whence most of our figs are obtained, the first crop ripens in June. The summer crops then begin to form; it is this which is dried, and packed in boxes and baskets, and sent to various countries: about 1000 tons are

yearly brought to us. After the summer crop has ripened there appears a third crop, which often ripens on the tree after the leaves are shed, thus supplying the inhabitants with fresh fruit during a great part of the year.

Fir Cones.—The fruit of the various kinds of fir, pine, and cedar, consists, when ripe, of a number of hard dry scales, which are united together, in a conical form, round a central stalk. Each scale protects two seeds, which are destitute of any other covering. When the seeds are perfectly ripe the scales frequently start apart, so as to allow the ready escape of the seeds. These scales vary very much in the cones of the different firs: in some they are thin and flexible; in others they are of a large size, very thick and woody, being at the same time exceedingly hard. The size of the cones varies very much: some kinds of fir, as the common Scotch pine, bearing small cones; whilst other trees, of a not larger size, will be furnished with much larger ones.

The seeds of these cones also vary in size and hardness; some, as those of the stone pine, are large enough for the kernels to serve as food. For the sake of the oily seeds, the cones of this plant are brought in considerable numbers to this country from Norway.

The only use to which the fir cones in this country are applied is for burning as fuel. For this purpose they are collected in places where they abound; and, from their oily and resinous nature, they are useful in making fires, as they ignite quickly, and yield much flame.

Gum Arabic.—Gum Arabic is the produce of several kinds of acacia trees, which are natives of the sandy deserts of Africa, and the East Indies.

When the bark of these trees is wounded, a liquid oozes out, which hardens in semi-transparent lumps; and this is the gum generally known by the name of gum Arabic.

Similar lumps of gum may be obtained from the plum and cherry tree of our gardens; when a rupture is made in the bark, this mucilaginous substance oozes out.

The use of gum depends on its ready solubility in water, and its adhesiveness when melted. The solution of gum, or gum-water, as it is usually called, is much used for sticking

light and thin objects together, fastening labels on glass, or for any delicate work; but not where great tenacity is required. It is also employed extensively in the arts, in stiffening crapes and other fabrics, and in the manufacture of ink.

Hazel Nut.—The common hazel grows wild in England. It is also a native of all the cooler parts of Europe, Asia, and North America.

It forms a small shrubby tree, very common in hedgerows and coppices.

In the autumn the barren blossoms of the next season begin to form; these continue to grow during the winter, and in the spring they appear as long drooping cylindrical scaly bodies, which are called catkins.

The fertile blosoms, which at first resemble small scaly buds, make their appearance in February, before the leaves are to be seen they are small, and of a bright red colour.

The filbert is merely a variety of the hazel, improved by cultivation. Both these shrubs are rendered very ornamental by the drooping catkins which hang from their branches during winter. The ripe fruit of the hazel consists of a nut enclosed in a husk, which, when fresh, is green, jagged at the margin, and of an acrid and bitter taste; it surrounds the nut, which consists of a firm and brittle shell enclosing a kernel, of an agreeable flavour. When ripe, this fruit contains a quantity of oil, which is readily extracted by pressure; it is termed nut oil, and is much used by painters.

Hazel nuts form a very large portion of the food of the squirrel, who lays up, in cracks of trees, a store of them against the winter. The dormouse, which feeds chiefly on them, does the same.

The wood of the hazel is excessively tough, and on this account is much used for making hoops for casks, stakes, hurdles, &c.

Hops.—Hops are the produce of a coarse, rough, climbing plant, which attains the height of several feet, twining for support round the hedges or poles near which it grows. It is furnished with opposite heart-shaped leaves, toothed like a saw at the edge, and extremely harsh to the touch, from the presence of minute points or hairs.

The flowers are of two kinds, barren and fertile; both are of a pale green colour; the former being small and grouped together; the latter, or fertile flower, consists of thin green scales, each of which covers a single seed vessel containing one seed. These seed-bearing flowers are collected together in cone-shaped heads, which increase in size; and, when ripe, form the substance known to us under the name of hops. The inner surface of these scales, and the surface of the seed vessels, produce a powdery substance, in which the bitter principle of the hop chiefly resides.

The hop grows wild in many parts of our country, and it is greatly cultivated in Kent, in fields called hop-grounds. Long poles are placed at the root of the plants in the spring, and as the plants grow they twine round them, hanging in beautiful festoons. At the hop-picking season the poles and the plants are taken up and laid across large baskets, into which the seed vessels are put. At this time most of the labouring people of Kent are employed in hop-picking, from the smallest child to the aged men and women.

The great use of hops, and the purpose for which they are so largely cultivated in this country, is as an ingredient in making beer. Their utility depends upon their bitterness, which gives to the liquor an agreeable taste, and wholesome properties, and upon their strong aromatic flavour; whilst the presence of a considerable amount of astringency stops the fermentation of the beer, and prevents it turning sour.

The hop is valuable as a medicine, from its strengthening and tonic properties.

Indian Rubber.—This substance is the produce of several trees, which are natives of the warmer parts of South America.

It is obtained by making incisions in the bark during the rainy season, when a thick milky juice, of a yellowish-white colour, flows out. If this juice is at once corked up in bottles, it will remain some time without undergoing much change; but if it is exposed to the air, it soon dries, and becomes the substance we call Indian rubber.

The natives of South America spread the juice, as it flows from the trees, on moulds of clay, and as soon as one coat is dry they apply another, and so on, until it has acquired

sufficient thickness. They hasten the drying by placing the moulds over a wood fire, the smoke from which blackens the Indian rubber, which would otherwise be white. The clay moulds on which the soft juice is spread to harden are usually shaped like a large pear; when the whole is dry they are easily broken and the pieces removed, and the Indian rubber is left in the form of a hollow bottle.

Indian rubber, as we receive it in this country, is a soft, pliable, and highly elastic substance; tough, and difficult to be cut. Its elasticity is much increased by warmth; and, on the contrary, if allowed to remain long undisturbed in the cold, it is much diminished.

If heated considerably, India rubber melts, but it does not become solid again on cooling. If set fire to it burns with a white flame, gives out much smoke, and a peculiar odour. It is quite insoluble in water, and even in spirits.

Indian rubber is a substance of great use, not only to the natives of the climates where it is produced, but to us and other nations. The inhabitants of South America form waterproof boots, by spreading the milky juice of the tree, before it hardens, on cloth. They also use the bottles into which they first shape the substance, and they make torches of it.

In this country it was for many years only used to rub out the marks of black-lead pencils, and from this circumstance it took its name; but a late discovery, that a fluid obtained from coal tar dissolves it, and on drying leaves it unchanged, renders it an article of extreme utility.

This dissolved Indian rubber is now used for many purposes. Water-proof, or "Macintosh" cloth, as it is called, from the name of the inventor, is made by spreading the dissolved Indian rubber on a piece of cloth, pressing another piece on it, and passing the whole through rollers. In a short time, the coal tar naphtha flies off, and leaves the two pieces of cloth firmly connected together by the interposed Indian rubber. The fabric is quite water-proof, and even air-proof, so that bags of it may be blown up like a bladder, and used as pillows or cushions. Its great use, however, is in making water-proof caps, cloaks, and great coats. The dissolved Indian rubber is also used, instead of glue, in binding books, and it holds the paper so firmly that threads are

not required. Water-proof shoes are made of Indian rubb thin sheets being formed to the shape of the foot. It also much used in surgical apparatus, for forming elastic ba dages, &c.

Ink.—Writing ink is an opaque, black liquid, much us for writing on paper, parchments, &c.

The principal ingredients used in making ink are, gre vitriol, or sulphate of iron, nut-galls, gum, and water.

The nut-galls, coarsely powdered, are usually boiled in part of the water first, so that the latter may dissolve out their astringent particles. To this liquid, when straine the gum and the green vitriol, previously dissolved in wat are added; a chemical change immediately takes place in t mixture, and a black colour is produced, which is insolub in water, and would sink to the bottom if the gum were n present to thicken the ink, and so suspend the colour. T colour of ink is not very deep when first made, but it becom much darker on exposure to the air for a few days.

In the wholesale manufacture of ink, logwood and bl vitriol, a preparation of copper, are both frequently added, improve the colour. The use of the latter is attended wi two serious inconveniences; it causes the ink to act on ste pens, and penknives, coating them with copper and rapid spoiling them; and what is even still worse, it renders in exceedingly poisonous, for these reasons, though it muc improves the colour of the ink, it is better to omit it.

Moss.—Mosses are small plants, not exceeding a fe inches in height, found growing in all parts of the worl though much more abundant in cold or damp temperat climates than in the tropics, or in very dry situations. The are covered with small, usually bright green leaves, very thi and membranous, and are destitute of flowers, having, insteac small urn-shaped cases, which are supported by long stalks Each of these cases is at first covered by a long pointe cover, resembling an extinguisher; this falls off, and the urn like case is exposed, with its opening at the top closed by small lid, which, when removed, displays a fringe of smal teeth. Upon separating these teeth the case may be observed to be filled with an excessively fine powder, which is the sec

he moss, and when carried by the wind sows itself, and duces plants similar to the one by which it was formed. se cases are usually formed in winter weather, as the ts of summer dry up the plants, and they cease vegetating.

he use of mosses to man is but small and unimportant. Laplanders use them for bedding; and in some parts of north of England they are formed into elastic mattrasses; lst the larger kinds are made into door-mats, and even small brooms. The common bog moss is much used for king, especially for preserving the roots of trees during nsplantation.

lthough their immediate benefit to man is but small, yet use of mosses in nature is very great. They grow where er plants could not exist; upon barren rocks, mountains, walls; they cover over the fallen trunks of decaying trees, l then, by their decay, form a vegetable mould, in which ger plants, as grasses, &c., can grow. As an instance of ir power of forming soil may be mentioned, that a tuft noss, weighing six ounces, was found growing on the top some bare tiles, upon washing away the mould from the ts it was found that the moss itself weighed only one nce; and that the soil it had produced, by the decay of its d leaves, weighed the remaining five.

The peat soil of bogs is formed, in great part, of decayed sses, which are constantly growing in full luxuriance upon damp surface of such ground.

Besides these uses, mosses serve as a habitation to many ds of insects, especially in the winter. These insects, at h times, furnish, in their turn, food for birds, who are o indebted to moss for a considerable portion of the material of their nests.

An exceedingly small moss is found growing, in great undance, upon the walls of Jerusalem; and it is supposed t this is the plant alluded to by Solomon, when he consts the lofty cedars of Lebanon with the hyssop growing of the wall.

Neither of the familiar substances known under the names Iceland and Irish moss is a moss; the former being a d of lichen, and the latter a sea weed. (See Sea Weeds.)

Mustard Seeds.—The mustard in common use is the

seed produced by two annual herbaceous plants with yellow flowers, the four petals of which are arranged in the cross-like form, so characteristic of the wholesome and generally pungent tribe of plants to which they belong (the cruciform).

Both the plants are natives of this country. The seeds of one plant are pale yellow, or nearly white; hence it is termed white mustard, and the plant producing them is chiefly cultivated for small salad. Those of the other are dark reddish brown—the plant bearing them is called black mustard. The latter kind is chiefly used, the seeds being much more pungent than those of the former. It is cultivated very extensively in the counties of Durham and Yorkshire. The seeds are sown either with the drill, or by the hand broadcast, in March or April, after the ground has been prepared by ploughing and harrowing. When the plants are a few inches high they are thinned by hoeing, and in August or September, when the small yellow cross-shaped flowers have faded, leaving the seed vessel and seeds fit for gathering, the plants are cut down and tied in sheaves.

In preparing mustard for use, the seeds are ground in a mill, and the dark-coloured husk separated by fine sifting. Ground mustard, or flour of mustard, as it is sometimes termed, when mixed into a paste with water, forms the well-known condiment that is used to flavour our food, and to quicken digestion by stimulating the stomach to more rapid action.

Ground mustard also forms an extremely useful and safe emetic where poison has been taken; a large table-spoonful of the powder in a glass of water acting immediately. It is also used to aid the effects of hot foot-baths, as by its stimulating properties it causes a great determination of blood to the skin from any affected part.

White mustard is cultivated for salad, the young plants being cut when about two inches high. Some years since the seed was much used as a cure for many complaints, when swallowed whole in water; but its use was much more injurious than beneficial.

It may be mentioned that the mustard plant, though produced from so small a seed, attains a large size in hot climates, and was hence chosen by our Saviour as a subject for one of the parables—Matt. xiii. 31; Mark iv. 30; Luke xiii. 18.

As, however, it does not become a tree, it is supposed by many writers that another plant was alluded to.

Nutgalls.—These useful substances are the produce of a small shrubby oak that grows abundantly in all the countries of Asia Minor. Its stature is so low that it ought to be considered as a shrub rather than a tree, not attaining a greater height than six feet. The nutgalls, although produced on the plant, are not its fruit (which resembles that of our oaks, being acorns), but are caused by a small insect which pierces the bark of the young shoots, and deposits its egg in the hole; the presence of the egg causes a swelling to take place, which is the gall. The eggs are hatched in the gallnuts, they become larvæ or grubs, and feed on the substance of the gall that contains them; after a certain time they turn to the perfect insects, which soon gnaw their way out, leaving a small hole in the side of the nutgall. On looking at a number of galls, we find that some are pierced with this round aperture, whilst others are not—the latter are considered the most valuable in commerce, if broken, they will be found to contain the remains of the grub, or not unfrequently the perfect insect. Galls are in perfection when they have arrived at their full size and weight, yet before they are pierced by the insect. They are gathered by hand for sale. Of all vegetable substances, nutgalls are by far the most astringent. This we might be led to expect, as they are produced from the juice of the oak, which abounds in astringent matter. (See Oak Bark.)

They are used in the manufacture of ink, as they have the property of producing a black colour when mixed with green vitriol (a preparation of iron). They are also used in dyeing cloths black and other colours, and also occasionally in medicine.

Oak Bark.—The stems of trees growing in temperate climates have a covering called bark; this not only protects the growing wood, but serves as a channel down which the sap that has been prepared in the leaves descends. This descending sap, having been exposed in the leaves to the action of the sun and air, is charged with the peculiar products of the plant; and as it descends by the bark, this last is

also highly charged with them. It is from this circumstance that the bark is selected in preference to the wood when we wish to obtain the peculiar principle of any plant. The bark of the oak, therefore, contains a much larger proportion of the astringent matter of the plant than the wood. Its great use is to convert hides into leather; it is carefully removed from the tree, and is then ground into a coarse powder between iron rollers, and placed in layers between the skins in the tan-pit. The skins of animals consist in a great part of a substance similar to glue, which is soluble in water, and very perishable. When this is acted upon by the astringent part of the oak bark, the two unite and form the insoluble and durable substance called leather.

After all the astringent part of the coarsely powdered oak bark has been absorbed, the refuse is used sometimes to keep up the heat in hotbeds, for as it gradually decays it gives out a mild warmth; and at other times it is pressed into a solid mass, dried, and sold for burning as a kind of turf.

Much more oak bark is used in this country for tanning hides than our own oaks will supply; therefore large quantities are imported from the Netherlands, Germany, and other countries.

Olive Oil.—This liquid is the produce of the fruit of the olive, which is crushed when fully ripe, and the oil pressed out. Thus obtained, it is a pale yellow liquid, with a bland oily taste, and destitute of smell. In the warm countries of the south of Europe and Syria, of which the olive is a native, the oil has been in use from the earliest periods of which we have any record (Exod. xxvii), both for burning in lamps and for food. For these purposes it is well adapted; it is readily inflammable, and burns with a clear flame and without smoke: and from its being without any unpleasant odour, and not being liable to turn rancid, it is much used for food.

Another use to which olive oil was applied in the East was for the purpose of making ointments, which were used in anointing; these were made of spices of the most expensive kind mixed together with oil. In this country, at the present time, oil is used for food and for the preparation of medical ointments, &c.

Oils of a cheaper kind, obtained from animals, as the whale and seal, are used for burning in lamps.

Another important use of oils is for the purpose of making paint: when mixed with chemical substances of a drying nature, and exposed to the air, they become hard and dry; and if in this state they are laid on wood, &c., they form a kind of varnish that perfectly resists the dampness of our climate, and much preserves the wood. When white lead is added so as to render the mixture perfectly opaque, it is called paint, and various colours are generally added to produce the tints required.

Olive oil, from its great price, is not usually employed for making paints, but that prepared from the seeds of the flax or linseed. (See LINSEED.)

PAPER.—This valuable material is manufactured almost entirely from various kinds of rags. In this country so great is the demand for rags for this purpose, that they are imported in immense quantities from Germany and other parts of Europe. The first operation in making paper is the sorting of the rags according to their various degrees of fineness, and at the same time they are cut into small shreds; these shreds are then beaten and shaken in a machine, so as to free them as much as possible from dust and dirt. The rags are then washed, and afterwards ground to a pulp in water by means of a machine of rather a complicated construction; it consists of a large cistern to contain the water and the rags to be converted into pulp. In this cistern turns round with immense rapidity a cylinder like a drum, from the sides of which project a number of blades or cutters; these, as the cylinder turns round in the water, have their cutting edges brought close to those of another set of cutters fixed to the cistern, and as the rags are caught between the knives they are rapidly cut or torn up, and reduced to a pulp, which is blackened by the addition of chloride of lime. (See CHLORIDE of LIME.)

This pulp being again well beaten, so as to render it exceedingly smooth, is mixed with some size or thin glue; and for the manufacture of some papers a small quantity of blue, as indigo, is added.

Formerly, from the pulp thus prepared, the paper was

made by hand; but latterly by far the greatest quantity is made by a machine.

In the former case the paper was made in sheets the size required for use, but by the machine in pieces of immense length—viz., from twenty to thirty feet, and five feet in breadth. It is stated that the machines now at work in Great Britain make nearly 2000 miles of paper four or five feet broad every day. The formation of the machine is very complicated, and could not be understood without the aid of engravings; therefore the mode of making paper by hand will be described, the principle being the same in both cases; for whatever plan is adopted, the object is to separate from the pulp the water it contains, and to cause the former to assume the shape of a sheet of paper. The worker stands by the side of a vat containing the pulp well mixed; into this he dips a kind of sieve called a mould, on which he takes up a small quantity of pulp; this sieve is formed of wires, the arrangement of which varies with the kind of paper required: for foolscap the wires are separate and run parallel, giving that paper its peculiar ribbed appearance. Wove paper is so called from the sieve or mould being formed of wires woven into a fine cloth, with about fifty or sixty meshes to the inch.

Usually the maker's name and the date are marked on the mould by sewing in a piece of wire in the form of the letters required; this being raised above the surface of the mould, makes the paper thinner at these parts. The pulp taken into the mould is, by shaking, spread very evenly over the whole surface, and the water drains away through the wires; when so much of the water has drained off as to leave the pulp tolerably firm, it is turned out on a piece of felted cloth, and upon it another piece of felt is laid to receive a second layer of half solid pulp; and so on alternately pulp and felt until six or eight quires are piled up. The whole is then pressed by machinery with a pressure equal to or exceeding 100 tons; by this immense force much of the water is driven out, and the paper becomes much more solid. Removed from the press, the felts and paper are separated by a boy, the former being again ready for immediate use. Two men working at the vat, and a boy to separate the felts and pressed papers, can make six or eight reams a day.

In the evening the whole of the paper made during the day

is placed in a press, where it remains all night; this somewhat smooths the surface, and gets rid of more of the moisture. It is then separated and hung on ropes to dry.

From the drying room it is removed to be sized; this is accomplished by dipping about four quires at once into a kind of size or thin glue (see GLUE), each sheet being moistened equally. The whole is once more pressed, and again dried slowly for some days. The paper is now finished, with the exception of pressing once or twice, so as to give it a smooth and even surface. It is then sent to the finisher, who counts the sheets into reams and does them up; so great is the rapidity acquired by practice, that a good finisher will count 200 reams, or 96,000 sheets, a day.

Several kinds of paper are made from various materials, as they are required to answer different purposes.

Brown paper, in use for packing up heavy articles, is made from canvas, sackcloth, and other strong hempen materials. Whity brown paper is a cheap paper used for wrapping up small articles; is made thin, and of rather finer materials.

Blotting paper is made without being much pressed, and is not sized; so that it is porous and very absorbent, readily sucking up, like a sponge, the superfluous ink from writing—the pulp for this paper is usually coloured in making.

Foolscap is a paper of large size, made on a mould whose wires are parallel. Letter, or wove paper, is formed on a mould of closely woven wire gauze. It is sometimes left white; at others dyed, when in a state of pulp, with indigo, or a dye called smalt; this is called blue, the other yellow, wove.

Hot pressed or satin paper is merely the best Bath or letter paper, sheets of which are placed alternately between very smooth pasteboards, and between every fifty pasteboards a hot sheet of iron is put; the whole is then pressed with immense force, when the warmth from the iron penetrates the pile, and with the pressure gives an exceedingly smooth surface to the paper. Silver paper is a very thin paper used for ornaments, and usually made without much size.

Pasteboard and card consist merely of several thicknesses of paper pasted together, and made to adhere by being firmly pressed together.

Pearlash.—Pearlash is an alkaline substance obtained from wood ashes. Our great supply of pearlash is from America, where the trees are often cut down and burnt, solely for the purpose of manufacturing this article. The ashes of the burnt timber are collected and put into cisterns; water is poured upon them, which dissolves all the soluble parts of the ash, and, after standing some hours to become clear, is drawn off and evaporated to dryness in iron pots, when the half-melted pearlash remains.

It is brought to this country in casks, containing about five hundredweight.

Pearlash obtained by this process is usually of a greyish colour, from the presence of impurities; but it is readily freed from these by dissolving it carefully in water, and evaporating the clear liquor.

Pearlash when pure is a white substance of an acrid caustic taste, easily soluble in water; with which it has so great a disposition to unite, as to attract it from the air, unless it is kept in closely corked vessels or casks. It is an article of great importance in many of our manufactures. Soft soap is in part composed of it; many kinds of glass are made by its aid (see Glass). It is also used by scourers in cleaning wool, &c.; and its use in removing grease and scouring wood-work, paint, &c. is very great: although it is now not so much employed for these latter purposes as soda, a substance somewhat similar in properties, but much cheaper in price.

Soda (which does not attract moisture from the air) is prepared by a complicated chemical process from common salt.

Peas.—The common pea was originally a native of the south of Europe, but is now extensively cultivated in all temperate climates.

It is a climbing plant, with leaves divided into six leaflets; the main stalk of the leaf proceeds beyond the last pair of leaflets, and forms the tendril by which the plant clings for support, the stem being too weak to rear it in the air without assistance. This tendril has the singular power of twisting itself around the smaller twigs of those plants to which the pea naturally clings for support. Few circumstances more clearly prove the design and wisdom of the

Creator, as shown in his works, than the numberless instances of compensation that we so constantly meet with. Animals, for instance, denied the possession of some one sense, are compensated for its absence by the great perfection of another which answers their wants more perfectly; or, as in the present case, a plant destitute of the power to raise its leaves and flowers, and expose them to the genial influences of the sun and air, is more than compensated for its weakness by the contrivance which enables it to borrow that support which it needs from other plants.

The flowers of the pea are of that kind termed butterfly-shaped. They are sometimes white, and at others coloured; each flower is succeeded by a pod dividing, when ripe, into two parts, both of which have a row of seeds or peas; each pea consists of an outer skin inclosing two half round portions, connected together as in the bean. The description of which may be referred to as applicable also to the various parts of the pea.

The art of man in cultivation has produced several varieties of the pea, the seeds of which ripen some earlier, others later. They all require a rich sandy soil, and should be furnished with sticks so that they may climb. Some kinds are used fresh and young, and are termed green peas.

The ripe dried peas, when split and separated from the skin, are used for making soup, and for pudding; they are very nutritious, and form an exceedingly cheap and wholesome article of food, but they do not agree with all constitutions.

RAISINS.—Raisins, or dried grapes, are the produce of the vine. This plant, although now cultivated in all the warmer regions of the globe, was originally a native of Asia, from whence it spread into Europe, Africa, and even the New World.

The grapes of Palestine are now, as well as in the time of Moses, of a larger size than those of other countries.

Although the vine is grown in this country, and the grapes are eatable, yet they do not arrive at perfection. Wine, for instance, cannot be made from them without the addition of sugar. Neither is the sun powerful enough to dry them so

as to form raisins. We are dependent, therefore, on other countries for this dried fruit.

In Valencia, from whence our great supply is obtained, raisins are formed by cutting the bunches of grapes, dipping them in a kind of lye made of wood ashes and lime; the lye is heated, the grapes are placed in a vessel full of holes, and the whole put into the hot lye; the grapes are then taken out of the vessel, and spread out on leaves placed on the ground, when they are rapidly dried by the heat of the sun.

The raisins called Malaga raisins are dried without being dipped in lye; hence their different appearance and flavour. The effect of the lye is to soften the skin of the fruit, and to render it less tough; whereas those dried without being dipped have tough skins, but the flavour is much superior. Hence Valencia raisins are used for pastry, the others for eating raw.

Saffron.—Saffron is the produce of the purple crocus, a plant much cultivated in our gardens for its beauty, and growing wild in many parts of England, but originally brought from the East.

The leaves appear in the spring, whilst the plant does not flower until the following September. Each flower consists of a long tube, expanding at the top into six purple petals. In the centre of the tube grows the style, which is a slender, bright orange-coloured stalk, divided at the top into three stigmas, which are the thread-like bodies that form, when dried, the substance called saffron.

To obtain this substance the flowers are gathered early in the morning, before they open; the stigmas are picked out of them and carefully dried, by being spread out on horse-hair cloths over a stove. The saffron obtained in this country is superior to the foreign. The best is dried in loose fibres, when it is called hay saffron. The inferior kinds are pressed into flat cakes.

Saffron is distinguished by a peculiar aromatic odour, and a slight bitter taste. It is used to colour and flavour pastry, and as a dye. When thus employed it is soaked, or boiled in water, which extracts both its fine yellow colour and its flavour, and may then be used for the purposes required.

It was once much used in medicine, but is not now highly

esteemed. A plant bearing the somewhat similar name of "Meadow saffron, or Colchicum," is much used in medicine; care should be taken that it is not confounded with saffron, as its roots and seeds, the part employed, are exceedingly poisonous, and have frequently proved fatal.

Sago.—The nutritious food, known to us under this name, is the produce of a palm-tree growing in low marshy situations, in the peninsula of Molucca, and the adjacent islands.

The sago palm grows to about 25 or 30 feet in height; the trunk is thick and cylindrical (not tapering), destitute of branches, and bearing on its top a tuft of numerous leaves before the tree forms its fruit. The stem consists of a thin hard wall or shell outside, about two inches in thickness, the whole of the inner part of the trunk is filled with an immense quantity of a pithy substance, from which the sago is obtained. This pith disappears as the fruit ripens, the latter deriving its nourishment from the pith, and when the fruit is quite ripe the stem is merely a hollow shell, or cylinder.

The inhabitants of the Moluccas, to whom sago is the staff of life, obtain it by cutting down the tree close to the ground, splitting up the trunk, and taking out the pith, which they rub to powder and mix with water; after straining off, the water is left standing; the sago settles at the bottom, and after a few more washings it is fit for use; but before it is sent to this country it is again wetted with water, so as to make a paste, which is rubbed or rolled into the small grains we are acquainted with.

The quantity of sago yielded by each tree is immense; 500 or 600 pounds is a common produce for one palm.

Sago is a nutritious, wholesome food, of a starchy nature, light, and very easy of digestion, so that it is frequently used by invalids. It is now much employed as an article of food in this country, being valuable from its cheapness, and its wholesome properties. Many hundred tons are annually imported into this country.

Sawdust.—Sawdust is a coarsely powdered substance, consisting of the small pieces torn out of wood by the teeth of the saw, as they are forced through it in the act of sawing.

In colour it of course varies, with the wood from which it is obtained. It is commonly produced from deal, or fir woods, as they are in the most frequent use.

Sawdust is chiefly used for covering over floors on which any wet dirty substance is apt to fall, as it prevents the feet from slipping, and the floor from becoming soiled to so great an extent as it would otherwise be. For this purpose it is much used in many shops, as in those of butchers, &c.

It is also employed in stuffing dolls, pincushions, and similar articles; and in cellars, being placed between rows of bottles, so as to prevent their pressing irregularly upon, and thus breaking one another by their own weight.

Sealing-wax.—This is a substance employed for fastening letters and papers. Its use depends on the readiness with which it melts; on its adhesiveness when melted, which is sufficient to enable it to stick very firmly to paper, but not so great as to fix it to a polished seal; on its plastic nature, when fused, which allows it to receive any impression stamped upon it; and as it hardens when cold, it retains the image impressed upon it.

Sealing-wax, possessing these properties, is prepared from a resinous substance termed shell-lac (which is the produce of an insect, a native of the East Indies), melted with about one quarter of its weight of Venice turpentine, and coloured red by vermillion, or sometimes black, by lamp-black. These ingredients are all melted together, and well mixed by stirring; and, while still soft, either cast into moulds of the shape desired, or rolled into round sticks, on a smooth marble slab.

A cheaper kind of sealing-wax is made with resin and red lead, for sealing over the corks of wine-bottles, &c. &c.

Sea Weeds.—The name of sea weeds is given to those plants found growing in the waters of the ocean. Although very different in appearance from one another, they all agree in being quite destitute of flowers, and living in the water.

The largest kinds, and those which are most useful to man, consist, generally, of olive brown, or green, leathery, flat bodies; some being long, and strap-shaped; others are spread out into a more leaf-like form. They are at first attached to, and grow from the rocks, under the surface of the sea. Many

of them, as, for instance, the very common bladder wrack of our coast, require to be near the surface of the ocean, and for this purpose they are provided with small bladders, or air, to float them.

Many sea weeds are of great use to man. A few years ago the common kind were burnt on the coast of Scotland, to form kelp, from which soda was obtained; but now that substance is procured in a cheaper manner, by a chemical process, from sea salt.

Many kinds of sea weed are eaten by various nations, and they form, in general, a sweet and nutritious food. The substance called tangle, eaten in some parts of Scotland, is a sea weed; as is another, termed dulse. This latter is eaten by the fishermen both raw and roasted; and it also forms a great part of the food of various shell-fish.

A kind of dulse is barrelled for food by the Icelanders; and a species in Kamschatka contains so much sugar that it is fermented into intoxicating drink.

The Irish moss, or carrageen, is a sea weed; it is used in Ireland very largely as an article of food; it may be usefully employed instead of isinglass, in making jellies for invalids, for which purpose it is sold by druggists in England. In Ireland it is used also, instead of size or glue, by painters.

Laver, which is eaten as a delicacy by some persons, is also a kind of sea weed.

As food for animals these plants are of great importance. The bladder wrack of our shores is eaten by pigs in Gothland, where it is called swine tang; and by cattle in many of the Scottish Islands. A kind of dulse often tempts sheep, &c. in Iceland so far beyond high-water mark that they are drowned by the rapidly returning tide.

Some kinds of sea weed are useful as fuel. In Jersey the bladder wrack is dried for burning. And the Chinese make a most valuable glue from a kind that is common in their seas.

Soda.—Soda is an alkaline substance, well known to all from its great use in washing. Until a few years since soda was obtained from the ashes of burnt sea weed, in the same manner as pearlash is now procured from the ashes of land plants (see Pearlash); and not many years ago 20,000

persons were employed in the Orkney Islands alone, in collecting and burning sea weed for this purpose.

At the present time soda is obtained from sea salt by a very complicated chemical process, conducted on a most extensive scale, in manufactories in the northern parts of the kingdom, and in such abundance is it produced that it is sold retail at $1\frac{1}{2}d.$ per pound. As thus obtained, soda is usually in large crystals, which are transparent, readily soluble in water, and have a cooling, alkaline taste. They contain nearly two-thirds their weight of water, and if gently heated they melt.

If the crystals of soda are kept in a warm, dry place, the water they contain flies off, and a dry white powder is left, less than half the weight of the crystals.

Soda is an article of very great value in various arts; all the different kinds of soap (with the exception of soft soap) are made with fats, or oils, and soda (see SOAP). Its use in cleansing from dirt and grease, both clothes and wood-work, or paint, is well known. A small quantity placed in what is termed hard spring water will render it fit for washing, or boiling vegetables.

It is also a substance of considerable value in medicine.

SUGAR.—The sugar used in this country, both that called moist and the refined, is the produce of the sugar-cane, a native, originally, of the East Indies, but which is now extensively cultivated in the West Indies, the Brazils, &c. &c.

The stem of the sugar-cane is jointed, and without branches. It rises erect to the height of ten or twelve feet. The leaves, which are very long and narrow, rise singly from the joints, and they sheath or embrace the stem to the next joint above, like the leaves of our grasses. The top of the stem ends in a loose bundle of small downy flowers, of a very pale lilac colour, and about two feet long, giving to the plant a most elegant appearance. In the West Indies these blossoms are not seen, as the plant is cut down before they make their appearance.

The sugar-cane is always cultivated by sowing cuttings, the top joints being selected for planting, when the cane is cut down. The planting of the cane does not require to be renewed yearly; as, if the roots are left in the ground, fresh canes spring up for several years.

The sugar-cane, whilst growing, is subject to several injuries. They are sometimes destroyed by millions of small insects, that live on the juice; and, at other times, they are subject to the depredations of monkeys and rats.

When the canes are fully ripe, which usually is the case in March, they are cut down near the ground; and then, being divided into convenient lengths, are tied up in bundles, and conveyed to the mill, where they are crushed, and the juice squeezed out, by passing them between large iron rollers. The juice is immediately collected in a cistern, and boiled, with the addition of some lime, or lime-water, the use of which is to promote the separation of the impurities, in the form of scum, which rises to the surface, and is skimmed off. The clear liquor is then rapidly boiled, in order to thicken it, and to enable it to form into grains on cooling; when it is placed in hogsheads, in which it is sent to Europe. These casks have their bottoms pierced with holes, in order that the molasses, or that portion of the sugar that will not crystallize, may drain away, whilst the raw or moist sugar remains in the cask. The fuel used in boiling down the juice is the crushed cane, dried by exposure to the air. It is calculated that 110 canes will yield about five gallons of cane juice; and this quantity, boiled down, produces about six pounds of crystallized sugar. The molasses which drain from the casks and the scummings of the boilers are collected, and, being fermented and distilled, yield the ardent spirit known as rum.

Raw or moist sugar is converted into lump, loaf, or refined sugar, by a process termed refining. This was, until lately, performed by boiling it with white of eggs, blood, &c.; but now the art of refining sugar has wholly changed, and much more cleanly and improved means are employed.

The raw or moist sugar is first dissolved in water heated by steam, lime-water being added at the same time; the liquor is then filtered through thick folds of cloth. By this process it is freed from many impurities, and becomes transparent, although it is still coloured. The next stage of the process is the discolouration of the syrup; this is effected by allowing it to filter through beds or layers of animal charcoal, or bone-black, formed by heating bones in close iron vessels. This substance has the property of separating and

retaining the colouring matter of the syrup, which passes through the filter perfectly colourless. It is then pumped into covered boilers, and, by the aid of steam, is boiled down, or concentrated at a low temperature. This boiling down is continued until part of the sugar becomes solid; it is then poured into iron moulds of the well-known sugar-loaf shape. On cooling it becomes a solid mass of sugar; a small hole is then opened at the bottom of the mould, and a small quantity of impure syrup drains out; this is the substance sold as treacle.

Loaf sugar, as thus obtained, is a granular substance, formed of a number of small white and hard crystals adhering together. If pure, it has no smell, and its taste is simply sweet, without any other flavour. It is readily melted by heat.

As an article of food, sugar is exceedingly wholesome and nutritious. It is noticed, that during the making of sugar the negroes in the plantations, and even the horses and cattle which are fed on the green tops and refuse, grow fat and strong, though their labour is at that time much increased.

The general uses of sugar are well known. Sugar candy is formed by allowing a hot concentrated syrup to cool slowly, when it forms large crystals on threads placed in the liquor. Barley sugar is merely sugar melted by heat and cast in moulds.

Tea.—Tea is the produce of an evergreen shrub, a native of China, Japan, and some parts of India. The leaves, which are lance-shaped, somewhat like those of the myrtle, are serrated, or toothed like a saw at the edges, and, when fresh, are of a bright deep green. When full grown their length is about two inches. The flowers are small and white, and are succeeded by a seed vessel, or dry fruit, divided into three cells, each of which contains a single seed. The plants are raised from the seeds, two or three being dropped into the place where the shrubs are desired. The leaves are gathered several times during the year, the young leaves alone being plucked. The drying begins directly the leaves are gathered, and it is effected partly by the sun, and partly by charcoal fires. During the drying the leaves are rubbed between the hands, so as to roll them up; and, when over the fire, are

constantly stirred to prevent their scorching. When quite dry, they are either retained for use or sent to one of the seaport towns, where they are again dried, packed in chests lined with thin sheet-lead, and shipped for this and other countries.

There are two kinds of tea brought to this country, black and green: it is not ascertained whether these are produced by the same or different plants. The green tea appears to differ from the black chiefly in the leaves being gathered without the stalks, which are always present in the latter, and in being less heated in the drying. It is an error to suppose that its green colour is owing to its being dried on copper pans.

The mode in which tea is used as an almost universal article of diet in this country, is well known; and when taken in moderate quantities it is not injurious, as it cheers the spirits and refreshes the body; but, in large quantities, tea, or any other liquid is unwholesome, by weakening the tone of the stomach, and preventing the due digestion of food.

VINEGAR.—Vinegar is an acid liquor much used in flavouring food, and for pickling. It is readily obtained by allowing any liquid containing a small quantity of spirit to be exposed to the air, when a kind of fermentation goes on, by which the spirit is changed into the sour or acid principle of the vinegar. Formerly, vinegar was made by exposing weak wine, or a kind of malt liquor brewed without hops, for a long period to the air in open vats; but now the process is much more rapidly conducted, by allowing the liquor to flow through loose shavings, by which it is so much more exposed to the air, that it is changed into vinegar in less than two days. As thus obtained, vinegar is a reddish-brown coloured liquid, of an agreeable aromatic, but rather pungent odour, and a sour taste. It has been used as a condiment from the earliest times; and, in the sultry eastern countries, its cooling and acid properties cause it to be much valued. From its being so readily procured by allowing any weak spirituous liquor to become sour, it was generally employed, being used by the labourers in harvest time. (Ruth, ii. 14.) Its well-known effect on the teeth, when undiluted with water, supplies Solomon with an apt comparison. (Prov. x. 26.)

Vinegar, or sour wine, was the usual drink of the Roman

soldiers; and, mingled with myrrh, or some such bitter substance, it was offered to the Messiah when on the cross. By St. Matthew (xxvii. 34 and 48) the offered beverage is termed vinegar; by St. Mark, wine.

At the present time, in this country, vinegar is used for seasoning food, for preserving vegetable substances from decay, and for forming pickles. In large quantities, however, it has a very injurious effect, weakening so much the structure of the stomach as to prevent the food being digested.

Vinegar of a much stronger kind is now obtained, in large quantity, by heating wood to redness in iron vessels, when a sour liquor passes off in vapour, which, when purified, is found to contain the same acid as vinegar; this is much used in making pickles.

Wafers.—The wafers in common use for fastening letters are made with wheat flour. This is first stirred up with water so as to make a thin fluid, quite free from any lumps or unmixed portions of flour. Then, according to the colour required, various substances are mixed with it; such as vermillion, indigo, gamboge, lamp-black, &c. &c. The worker then takes a tool formed of two thin iron plates, which he can bring together like a pair of tongs or pincers, but which do not quite touch, leaving a small space between them as thick as the wafers are to be; he first slightly warms the plates, then gives them a thin coat of grease, when they are filled with the flour paste, closed together, and held over a charcoal fire. On being opened when cold, a thin cake of wafer is found nearly dry, brittle, and about as thick as an address card; this is by means of ring-shaped punches cut into small round pieces of the size required. The use of wafers depends upon their becoming when moistened both soft and adhesive; if in this state they are placed between two pieces of paper, and the latter pressed together, the wafer adheres to both, and when dry firmly unites them.

The substances used for colouring wafers are frequently poisonous. This is especially the case with the red ones, which are tinted with either red lead or vermillion, both unwholesome substances, and very injurious effects have resulted from their being moistened in the mouth when used in large numbers, in which case they should be dipped in a cup of water.

Coarse wafers, made with red lead and flour, are used for poisoning black beetles or cockroaches.

WALNUTS.—These nuts are the fruit of the walnut tree, which is not a native of this country, but of the warmer parts of Europe and Asia; and in the colder parts of our island it will not ripen its fruit.

The tree, which produces timber of a very valuable kind for use, as gun-stocks, &c., is of a beautiful appearance, bearing leaves which are divided into seven or nine divisions or leaflets, and two kinds of flowers, the barren blossoms being in long heads or catkins, which soon fall from the tree, whilst the fertile ones grow only two or three together, and are each succeeded by a large oval fleshy fruit, which consists of an outside green coating having a very bitter taste, and which possesses the property of dying the skin a dingy greenish yellow colour, which cannot be removed without much trouble; this green rind covers a hard oval shell, which consists of two pieces, each of which is deeply and irregularly grooved; this shell contains the seed or kernel, which is a very irregularly shaped body, covered by a brown skin.

The fruit of the walnut tree is useful for a variety of purposes; before the inner shell has become hard the whole fruit is pickled, and the juice obtained by crushing them in this state forms walnut ketchup. When ripe, the outer rind has been used as a dye for staining wool, hair. &c., of a greenish yellow colour.

The kernel forms a delicious and nutritious article of food; it contains a very large quantity of oil, even as much as half its weight. This oil is extracted by pressure, and is of considerable value to painters and varnishers from the property it posseses of drying very quickly; and in some countries it is used for food in the same manner as salad or olive oil.

WILLOW OR OSIER.—In this and other temperate countries grow a large number of trees known by the names of willows, osiers, or sallows. They are found in damp and watery situations, some attaining the size of large trees, whilst others are small plants; both kinds bearing long straight twigs.

The great value of the willow and osier depends on the

long straight shoots they put forth, which are very flexible, exceedingly tough, and of very rapid growth. These circumstances have caused them to be selected for the purpose of making baskets, hampers, crates, &c. When employed for large baskets, the largest shoots are taken, and the bark is not removed; for smaller baskets the bark is stripped off; and for still finer work the shoots are split into small strips, which are worked up into hats, and even bonnets, fine baskets, &c. &c.; they are previously bleached by being held over burning sulphur. Besides its use for basket-work, the toughness of the willow leads the cooper to use it for the hoops of casks; for which purpose the larger shoots are split down the centre, and the ends being fastened together form hoops, the flat split side fitting closely to the cask.

OBJECTS

DERIVED FROM

THE ANIMAL KINGDOM.

SHELLS.

INTRODUCTION.—Shells are the hard substances that cover, and at the same time protect, the bodies of the animals that inhabit them. These animals are soft, fleshy, and cold to the touch; they differ from the higher animals in not possessing an internal framework, or skeleton, and in having cold and white blood, also in the absence of a brain, and in their senses being usually less developed.

The shells themselves consist of chalk, or carbonate of lime, mixed with animal matter; they are formed from the skin of the animal they enclose; when the latter is small, the shell is small also; and as the animal grows, it enlarges the shell, by adding to it at the edge of the opening.

As the shell is thus formed upon the animal, its shape, of course, depends entirely on that of its inmate.

The various colours that adorn shells are deposited from glands in the skin of the animal, when the substance of the shell is still soft.

Besides this power of constructing their habitations, they have the power also of repairing them when any breach has been made in them.

Shells are interesting to us, not only on account of the use of the animals as food, but from their beauty, and the wisdom displayed in their structure; for we find each shell suited to the position in which it is placed: some, by their impenetrable hardness, are well adapted to the rapid rivers in which they are found; others, which are fragile, are, by their very light-

ness, preserved from being thrown with force against any substance, and they float on the surface of the sea uninjured.

To the natives of savage countries, shells are especially valuable; of broken pieces they make substitutes for knives; they also use them to form their arrow and spear-heads, and even their fish-hooks; they are also used as vessels for holding liquids.

In many parts of America, lime is obtained in large quantity from shells, the animal part of which has been destroyed by burning.

Shells have been arranged in three great divisions or classes; those which are formed of one piece, or valve, are called univalve, as the snail, whelk, &c.; those formed of two pieces, joined together by a hinge, are called bivalves, as the oyster, mussel, &c.; and those formed of several pieces, are called multivalves, the most familiar instance is the barnacle.

Shells of One Piece, or Univalve Shells.—The principal parts of a univalve shell are the *whorls;* they are the parts that roll round and form the *spire*, the largest one being called the *body whorl;* the *mouth,* which is the entrance into the shell; the *lips,* which form the edge of the mouth; the *base,* which is the largest part of the shell; and the *point* or *top*. Some shells have a projection at the bottom of the mouth: this is called a *beak ;* the inside of the beak is a *canal,* in which the trunk of the animal fits. The animals inhabiting such shells have a head distinct from the body, and generally furnished with long organs, termed feelers; they have also eyes, and a fleshy foot, on which they crawl.

Snail Shell.—This shell is an univalve of a conical form, with a large swelling body whorl, a smooth surface, and round mouth. Its inhabitant is one of the pulpy animals distinguished by crawling on a broad fleshy foot, which is placed on the under part of the body; it has a distinct head, with mouth, &c., and four feelers, the two upper and longer of which, carry at their ends the eyes, which appear like black spots. The food of the snail is entirely vegetable; during winter they become torpid, and close the mouth or opening of the shell with a thin lid, which they have the power of forming. In dry weather, even in the greatest warmth of

summer, they will close up the shell as described. Also, if they are put into a box without food, they will attach themselves to the side, and become torpid, in which state they will remain for years, and will immediately revive if moistened with water. The writer cannot call to mind a more beautiful instance than this of the infinite wisdom and goodness of the great Creator: not only are these animals enabled to abstain from food during winter, but when occasional dry weather has parched up the vegetables on which they subsist, they have the power of becoming dormant; whilst the same refreshing shower that restores the green herbs, brings back again to life those beings whose food they form. As the snail is not exposed to the violence of the waves, it does not require a strong shell like that of the periwinkle; it is therefore provided with a thin light one, that does not encumber its movements; and it is an acknowledged fact that no art could form a substance, affording the protection it does, of so light a weight. Various kinds of snails have been employed as food; a very large kind was anciently fatted for the table by the Romans, and is now eaten by the Roman Catholic inhabitants of many parts of Europe during Lent; this kind has been introduced in this country, and is now very common in the chalk hills of Surrey and other parts. The common garden snail has been employed as food in consumptive cases, as it is extremely nutritious and easy of digestion. From the power that snails possess of becoming torpid during drought, they are enabled to inhabit the most desert plains; and on the small tufts of coarse grass and herbage found there, large snails are abundant, and it has been thought that they formed part of the food of the Israelites, during their passage from Egypt, as large ones are abundant, and to the present day are eaten as a delicacy in Egypt. Snails form the favourite food of birds of the thrush kind, whether in a wild or confined state.

Periwinkle.—The periwinkle differs in several respects from the snail, as we should be led to expect, on reflecting that the snail inhabits the land, whilst the periwinkle is exposed to the violence of the waves dashing on the shore. The shell of the snail is thin and delicate, that of the periwinkle of immense strength; it will in fact support the weight of a

person standing on it without being crushed. In form they are both very much alike; the periwinkle is more pointed, having five or six whorls. The body whorl is larger than all the rest put together; the old shell is of a smooth and brown colour; the young ones more yellow or reddish. The animal has a strong lid with which to close the mouth of the shell; of this the snail is destitute. The periwinkle is very extensively used for food, and is found in great numbers on rocks and stones, when left bare by the ebbing of the sea; it is generally collected by children, and eaten after being plainly boiled.

Whelk.—This shell is very common on many parts of our coast. It is formed of seven or eight rounded whorls, which are rough with stripes or ribs; it is of an oval shape, and is a coarse-looking shell of a dingy white or brownish colour; the mouth is oval, and has a notch or short canal at the bottom. The animal it contains does not feed on sea plants, but on other animals, even those enclosed in, and protected by, hard shells. In order that it may obtain the food natural to it, it is furnished with a trunk or proboscis, which has at the end a number of small teeth; with this instrument it bores through shells, and extracts the soft parts of the animal, on which it feeds. The destructive powers of a kind of whelk proved very annoying to the builders and light-keepers of the Bell Rock Lighthouse. The workmen had obtained a number of a large kind of mussels, and endeavoured to plant a colony of them on the rock, for use as food, and for bait; the mussels were soon observed to open their shells and to die in great numbers; and it was ascertained that the rock whelk, with its proboscis, bored a small hole in the shells, and sucked out the finer parts of the body of the mussel, which, of course, after this, perished. It was also remarked that the whelk always bored the thinnest part of the mussel shell, and that the hole was beautifully smooth and circular. As the mussels were of great importance to the men, they endeavoured to destroy their enemies; but they were so numerous that all their efforts to extirpate them, were in vain, and in three years afterwards the mussels were all destroyed. The principal use of the whelk is as bait for fish. They furnish but indifferent food, as they are hard and indigestible; they are, however, liked

by some persons; but, except in seasons of scarcity, are not generally eaten.

LIMPET.—The shell of the limpet is remarkable for its form. It is simply conical without, and concave within, not having the spiral whorls of most univalve shells. The animal inhabiting it is furnished with a pair of feelers, with eyes, and a hard firm mouth for the mastication of its food. It has also a broad fleshy foot, with which it fixes itself to rocks and stones; when it desires to do so, it causes a vacuum in the interior of the shell; and the air outside presses it on the rock, having no counteracting pressure from within. It is on the same principle that a boy's leather sucker is held firmly to the stone or brick which it is pressed upon. This simple contrivance enables the limpet to adhere with such extreme tenacity to the rock upon which it is fixed, that it is with difficulty dislodged. Its conical form is also fitted to break the violence of the waves that dash against the rock: and thus this little animal from within its stony castle bids defiance to the storm, and magnifies the goodness of Him who, when he placed the limpet in an exposed situation, gave it the protection it would need. Although extremely common on the rocks of many parts of the coast, the limpet is not much eaten in this country. Among the villages of the coast of Scotland it is frequently used. Its juice, obtained by boiling, is mixed with oatmeal, and held in high estimation. The great use of the limpet is as a bait for the fish that are caught near the shore. The fishermen detach it from the rock by passing a knife beneath it.

SHELLS OF TWO PIECES, OR BIVALVES.—The two pieces or valves of which these shells are formed are united, at the part called the hinge, by an elastic ligament, the effect of which is to keep the shell open; but the animal, by means of strong muscles which pass from its body, and are attached inside to the valves, can close them at pleasure. It is these muscles that are cut away when the oyster is taken from its shell. At the hinge are often small prominences called teeth, and the points of the valves over the hinge are called beaks. The animals inhabiting these shells differ much from those of the univalves. They have no distinct head; consequently, no

eyes, nor feelers; and their mouth is merely a small aperture or hole. Some of them have a foot, by which they can creep slowly from place to place. Others, as the oyster, cement themselves to the rocks, and are incapable of motion. The food of these animals is found in the water in which they all live, and is washed into their shells, when they allow the elastic ligament to keep it open for that purpose.

Mussel.—The shell of the mussel consists of two pieces, of equal size, and of a similar shape, which is oval, and pointed at the beaks. The colour is dark brown; the inside is pearly white, blueish towards the edges. The animal has the power of fixing itself to one spot, or of moving from place to place, by means of a tongue-shaped foot, which it can push out of the shell to some distance, and draw in again. When they wish to move, they place the shell erect on its edge, and stretch out the foot. This, being sticky, adheres to the ground, and, when shortened, pulls the shell along. In this way, the mussel moves until it finds a convenient place of residence, when it forms a bundle of fine silky threads—one end of which it fastens to the rock, and the other is attached to the animal; and thus it remains securely anchored. Mussels are found on our coasts in immense numbers, collected in beds, which are uncovered at low water. Women and children tear them away from the rocks and stones to which they are attached, by an iron hook. In England, they are sold as they are thus collected; but in France they are fattened as we fatten oysters. The mussel, which is usually eaten boiled or pickled, is rich, and not unwholesome when it is in season. In the spring time, however, it is to many persons injurious; as it is then liable to be diseased. This noxious quality was long thought to be owing to a small crab which often takes up its abode in the mussel-shell; but there seems to be no reason for believing this to be the case. The mussel is much used by fishermen as bait for catching both cod and haddock.

Oyster.—The shell of the oyster consists of two pieces, which are roundish, but very irregular in form, and are not alike; one being nearly flat, the other convex or bulging. The outside is very rough and scaly, and of a dingy colour. Oysters are found in the sea, with the lower or convex shell fixed

firmly or eemented to roeks or stones, or to one another. They prefer a rough and rocky bottom, to which the shells can adhcre firmly, better than a sandy one ; and they arc generally found in water varying from five to twenty fathoms in depth. They are fished up with a dredge, whieh is a kind of net with an iron scraper at the mouth—the use of whieh is to separate the oysters from the roeks. After being taken, thcy are plaeed, for six or eight weeks, in ponds of sea water to fatten. Oysters abound on the shores of Great Britain. The fishing for them gives employment to 10,000 people. Oysters form a light food, easy of digestion.

Mother of Pearl—This is the hard, silvery, brilliant substanee which forms the internal layer of several kinds of shells. The interior of our common oyster shells is of this nature ; but the mother of pearl used in the arts is much more variegated with a play of eolours. The large shells of the Indian seas alone have this pearly substance of sufficient thiekness to be of use. The play of eolours seen in mother of pearl depends on its peculiar structure. It has, even when polished, an immense number of small furrows running across the surface. These reflect the light in such a manner as to produee the various hues seen on the surface. These furrows, though too small to be pereeived by the naked eyc, may be easily seen with a microscope ; and impressions of them may even be taken in very fine black sealing-wax, which will then possess, to a considerable extent, the same changing coloured appearanee. Mother of pearl is used in the arts for forming small articles; as eounters, handles to knives, and salt-spoons, &c. &e. It is also much used for inlaying dark woods, with which its beautiful and varied surfaee forms a striking eontrast.

INSECTS.

Introduction.—Insects are a large and very numerous class of animals, distinguished by their form, which in general has the appearance of being cut into three parts—the head, trunk, and abdomen. They are also distinguished by passing through several changes before they arrive at the perfect state.

The bodies of insects are not (like those of the higher animals) supported by an internal framework of bones, but by the hardened and in most cases horny skin which gives shape to the body, and forms also the joints of the limbs.

The head of insects is covered with several distinct pieces of hardened skin. It usually supports two organs, or parts, which from their use are termed *feelers;* below these is the mouth, the direction of which is perpendicular. On the head also are placed the eyes, which are sometimes simple in their nature, sometimes very compound, each apparently simple eye consisting of a large number of eyes united together.

The trunk of insects supports the wings, of which there are usually two, as in the house-fly, or four, as in the butterfly. Sometimes the two upper wings are not used for flight, but are hardened into a horny covering for the protection of the two lower, which are then very thin and delicate; this is the case in the ladybird, cockchaffer, beetles, &c. From the trunk also spring the legs, which in all true insects are six in number.

The breathing of insects is not carried on by lungs, nor does the breath pass through the mouth, but enters into the body by several holes or pores on the sides.

The changes through which insects, properly so called, pass, are very singular. The animal when in the perfect state lays eggs usually in great numbers, which are of very various shapes, and covered with a skin, although destitute of a shell.

The warmth of the climate hatches these eggs into *larvæ*, or, as they are more frequently termed, *grubs, caterpillars*, or *maggots*. These larvæ are at first very small, but they usually eat voraciously, and grow with great rapidity. A silkworm, for instance, in thirty days weighs many thousand times its original weight.

During their continuance in the larva state, the growth is too great for the skin to enlarge sufficiently to contain the body of the animal; it is therefore changed several times. Arrived at its full size, the larva changes into a chrysalis, or *pupa;* in which state it is encased in a horny covering, is destitute of limbs and of the power of motion.

After a time, however, the animal bursts forth from this tomb, and appears as the perfect insect. Its life in this state is usually but short; it lays its eggs for the production of another generation, and dies.

In some insects the whole of these changes are not distinctly marked, the grub and perfect animal being very much alike; this is the case in the cockroach, &c.

Though small, insects are of vast importance in the world; many yield a number of useful products; whilst others remove with rapidity the decaying remains of animal and vegetable substances.

Bees.—Bees are the well-known insects that are domesticated, and kept in hives by man, for the purpose of yielding honey and wax. In their natural state they live in large societies, forming their habitation in the hollow of a tree or rock. (Deut. xxxii. 13; Ps. lxxxi. 16.) This is still the case in some parts of America; but in Europe they are seldom seen in a wild state.

Like most other insects, the bee is divided into three parts, —namely, the head, the chest or thorax, and the abdomen. The head, which is fastened to the chest by a thin neck, supports the feelers, the eyes, the mouth, and the various parts connected with it. The chest has the six legs and the four membranous wings attached to it; whilst the third part, or abdomen, consists of several rings, the last of which carries the sting.

In every hive there are three kinds of bees—the drones, the workers, and the queen.

The drones are easily distinguished by their nearly cylindrical form—the abdomen not tapering towards the tail; by their large eyes, which meet at the top of their head; their chest being thickly covered with short pale brown hair, resembling velvet, and the wings being large and rather longer than the body, and they are destitute of a sting. In each hive there are usually from 700 to 2000 drones.

The working bee is smaller than the drone, from which it is readily known by the abdomen tapering towards the tail, and by its wings not reaching quite to the end of the body. It is also armed with a straight sting. In a well-stocked hive there are from 15,000 to 20,000 working bees.

These bees are occupied in collecting honey, pollen or bee bread, a sort of varnish called propolis, in forming wax, building the combs, and attending to the young.

The honey is collected from flowers by means of the tongue, which is like a flat strap, and is used in lapping up the honey. This is swallowed by the bee, and is carried to the hive, where it is disgorged; part being used in feeding the young, and the rest stored up in the cells of the hive for winter consumption.

Pollen, or bee-bread, is a fine yellow dust collected by the bees from flowers; this is carried on the hind leg, the middle joint of which is made broad and furnished with a rim of strong hairs, so as to form a sort of basket, admirably adapted for the purpose to which it is applied. This pollen, or bee-bread, mixed with honey, forms the food of the young bees; for which use alone it is collected.

The substance termed propolis is a sort of resinous varnish, collected by the bees from the buds of trees; its use is to stop any holes in the hive, and to form some parts of the comb.

The queen bee is distinguished from the working bees by the great length of her abdomen, which is in the form of a lengthened cone; by the shortness of her wings, which do not reach more than half the length of her body; and she differs from the drones in being furnished with a sting.

In each hive there is but one queen, who is treated with the greatest respect by the other bees. It may be wondered, perhaps, how they can distinguish the queen in the dark hive; this, however, they do by the feelers.

If the queen is accidentally lost or destroyed, her absence is soon discovered by the workers, and the greatest confusion and disorder follows. They immediately proceed to supply her loss, by rearing up some of the young grubs with rich food, so that when hatched they are queens. The strongest of these young queens then kills the others, and retains possession of the hive.

If the queen be removed from the hive, and a strange queen immediately placed in her stead, the workers surround her and keep her prisoner till she dies of hunger. But if the strange queen be not introduced for twenty-four hours, she is treated very differently, being at once admitted to the sovereignty of the hive.

Should a strange queen be placed in a hive whilst the right queen is there, the two fight; one is killed by the stings of the other, who remains mistress of the hive.

The only occupation of the queen is to lay eggs in the cells prepared in the comb by the workers for that purpose; she takes no care of the young herself. The number of eggs laid by the queen is very great, sometimes as many as forty or fifty a day; one being laid in each cell. The egg is one-twelfth of an inch long, and of a cylindrical form, with rounded ends. In three or four days it is hatched, and becomes a grub or larva; this is immediately fed by the workers, with food consisting of honey and bee-bread mixed together. After five or six days the grub is full grown; it then spins for itself a silken lining to its cell, and turns into a pupa, or chrysalis, and in about eight days changes into a perfect insect.

The eggs that are intended to become queens are deposited in larger cells, and the grubs fed with more nutritious food. Shortly before the young queens are hatched, the old one becomes restless, and at last quits the hive with a great number of the bees, to seek a new home; and it is thus that the first swarm occurs. The next swarms are led off by the young queens, as they are hatched in succession; until at last the number of bees left is not large enough to furnish any fresh swarms; then the strongest of the young queens kills all the others, and remains mistress of the hive.

The usual number of swarms is two or three; in a very populous hive sometimes as many as five swarms are sent off; but this is rare.

Each swarm, as it quits the hive, usually clusters on some bush or tree in the neigbourhood; and, if it be not hived, will take possession, of a hollow tree, or some other convenient place. As soon as the swarm is accommodated with an empty hive, they proceed about building a comb. The first step to this is the formation of the wax. This substance is not, as was long supposed, collected by the bees from flowers, but is formed by them. During the operation they hang themselves in festoons from the top of the empty hive, and remain thus clinging to one another for some time. Whilst thus suspended the wax is formed in little scales, eight in number, which appear between the rings of the abdomen. After the wax is formed, the bees commence building the first comb, by placing the wax against the top of the hive. As fast as the wax is placed by one set of bees, another set commence hollowing it out into cells on each side, the wax that is dug out of the hollows being added to the edges of the cells to deepen them. As soon as the first comb is so far advanced as to contain two or three rows of cells, another comb is commenced on each side of it, about half an inch apart, so as to leave room for the passing of the bees. All the combs are begun at the roof of the hive, and built downwards. The hive when full consists of a number of these combs hanging perpendicularly from the roof, and about half an inch apart, with cells on both sides.

The cells are six-sided, and it has been proved by mathematical calculation that no other shape could be adopted without a waste of wax.

The cells in the comb serve for various purposes: some are for the queen to deposit the eggs in, where they are hatched into grubs, and finally into young bees. In another set of cells bee-bread is stored up, and some contain honey for winter use. The latter are joined to the sides of the hive, as the weight would break them down if they only hung from the top.

The bees never consume the honey that has been stored up, except in seasons of scarcity, as in winter; each cell, as it is filled with honey, being sealed up with a wax covering.

Bees'-wax.—Bees'-wax, the formation of which has already been described under the article "Bees," is prepared

for use by washing and melting the comb, the honey having been previously extracted; in this state it is yellow, and has a peculiar smell. As it is much used in this country, large quantities are brought from Africa, Cuba, and Russia. Yellow wax is freed from the impurities mixed with it by melting, when the heavier particles sink to the bottom, and the lighter rise to the top, and are removed by skimming. In this state it is cast in the form of cakes, and is used for making ointments, cements, &c.; it melts quickly under the heat of boiling water, and becomes soft at the temperature of the human body. If it is worked about in the warm hand, it quickly becomes sufficiently soft to take the impression of any object it is pressed upon, and it retains the form when cold and hard; in this manner wax is much used by dentists, &c. to take copies of small objects. But the great consumption of yellow wax is in the formation of white wax. This is accomplished by the process of bleaching; the yellow wax is first melted and freed from its impurities, and then formed into thin ribands or shavings, by pouring it into water. These ribands of wax are then laid upon canvas stretched between poles in the bleaching ground, where by the action of the sun upon them they finally become colourless, and are cast into small flat cakes and sold as white wax. In this state it is used for making artificial flowers and fruit, for waxing sewing thread, &c., but chiefly for making wax candles. The manufacture of wax candles differs from the mode adopted in making any other kind. Common candles are made by dipping the wicks into the melted tallow a sufficient number of times to render them fit for use; the name of dips is given them from the manner in which they are made. The candles called moulds are made by pouring the melted tallow into pewter moulds in which the wick is stretched; when cold the wick is pulled, and the candle comes readily out of the mould. But if wax were to be treated in the same way, it would not come out readily from the mould; therefore another mode is pursued in forming candles of this substance. The wicks are hung to a hoop suspended from the ceiling over a pan of melted wax; the workman pours over each wick a quantity of wax; this adheres to the wick; but as the candle will be larger at the bottom from the running down of the melted wax, it is unhooked and hung up again bottom upwards,

when wax is again poured over it, and it becomes of a more uniform cylindrical shape. It is then taken from the hoop, laid on a moist slab, and rolled with smooth boards until it is of the proper shape; and the required length is given it by cutting off the rough end. The wicks that are used for candles are made of loosely spun cotton. The use of candles for lighting is well known. When the wick is lighted a part of the wax or tallow is melted; this portion is drawn up by the wick into the flame, and there burns. In order to get the greatest amount of light from a candle, it should be snuffed frequently, as it then gives out much more light, and does not burn away faster. If the wick is long the flame is dull; that part of the tallow that would give out the most light, instead of burning, settles on the wick in large clots. It has been found by experiment that a candle immediately after snuffing gives the greatest amount of light, in twelve minutes time only one-third as much, in nineteen minutes less than a quarter, and in half an hour not one-sixth as much as at first.

Black Beetle, or Cockroach.—This annoying insect now so very common in many houses, and almost always found in bakehouses, corn-mills, and on board ships, was not originally a native of this country, but was brought here either from Asia or from America. When full grown it is about one inch long, of a dark brown colour, and nauseous disagreeable smell. The head, which is partly hidden by the chest, is furnished with two long thread-like feelers, each formed of a large number of minute joints. The male is readily distinguished from the female by its wings, which are covered by the wing cases, and extend half the length of the body. The female has only the rudiments of wings, and is much broader than the male. The eggs are usually sixteen in number, and are contained in an oblong case, which is at first white, but afterwards becomes brown and hard. Whilst this case is soft the female carries it about with her, being attached to the extremity of the body; afterwards she fixes it to various substances by means of a gummy matter. When the young escape from the egg, they are not in the form of grub, but appear very like the perfect insect, though they are destitute of wings. The cockroach does not, like the butterfly, undergo the complete set of insect transformations from egg to grub,

then to chrysalis, and lastly to the perfect insect. Cockroaches are nocturnal animals, exceedingly active at night, but concealing themselves in crevices, &c. during the day. They run extremely fast, and are very tenacious of life. Their food consists of meal, bread, and various eatables, raw potatoes, &c. They are extremely voracious, and when their usual food fails them, will devour almost anything that comes in their way, as woollen and silk garments, and even the upper leather of shoes.

The injury they do in some parts of Russia and Finland, where they are very numerous, is extreme. On shipboard also they are very numerous and destructive. They may be destroyed by poisoned wafers, or by catching them in a box with a glass top like a tea-cup without a bottom, down which they slip and cannot ascend; they are then readily destroyed by being thrown into boiling water.

Silkworm Moth, and its product.—The silkworm, though now spread over a great part of Europe, and even of America, originally came from China.

The animal is erroneously termed a worm, as it is really a kind of caterpillar, and passes through all the changes which so strikingly distinguish insects from other animals.

The eggs from which the silkworms are hatched are about the size of mustard seeds. The caterpillar or silkworm is at first very small, and of a dark colour; it however rapidly increases in size, becoming cream-coloured, and feeding voraciously on the leaves of the mulberry, which form its natural food.

In about eight weeks the animal arrives at its full growth, having during this period changed its skin four or even five times; before shedding each skin the silkworm refrains from eating, remaining in a quiet state; it then bursts the old skin near the head, and works its way out.

When full grown its length is from two and a half to three inches; it then commences forming the cocoon of silk, inclosed in which it lies as a chrysalis till it undergoes the change to a moth. The animal usually selects some corner in which to perform this operation, moving its head from side to side, and fixing the thread at different points, so as completely to inclose itself. As the worm is inside the cocoon, it

follows that the outside portions of it are first formed, and the interior last. In about five days the animal ceases to spin, having during that time diminished very much in length; it then becomes torpid, changes its skin, and appears in the form of a chrysalis inclosed in a dark brown hard case. In this state it remains from a fortnight to three weeks, and then changes into the moth or perfect insect, which is enabled to escape by softening a portion of the cocoon with a fluid which it has the power of forming.

The whole cocoon spun by the silkworm is not equally valuable; the external part is flossy, weak, and comparatively useless. The first process in obtaining the raw silk from the cocoon is the destruction of the chrysalis; this is easily performed by placing it in an oven heated considerably. After the animals are killed the rough outer floss is pulled off, and the cocoons are thrown into a vessel of hot water placed over a fire, in order to loosen the thread. The whole is then stirred with a bunch of twigs which catch the loose ends of the threads. Several of these taken together are wound off upon a reel; they are then tied up into hanks, which are ready for the use of the silk manufucturer, and are known by the name of raw silk.

In order to form a single pound of raw silk 2000 cocoons are necessary, the silk on each weighing about three and a half grains. Each cocoon is formed of one single unbroken thread, the length of which varies from 600 to 1000 feet.

The rearing of silkworms is not carried on to any extent in this country, as the climate is too cold, and the mulberry trees too late in putting forth their leaves. Our supplies of raw silk are chiefly obtained from the south of Europe and Asia.

A number of the cocoons are preserved each year, the animals not being destroyed, but allowed to complete their change and come forth as moths. These are of a pale cream colour, and are covered with a fine down: they are furnished with short combs like feelers, and do not use their wings to fly, merely fanning the air with them. After a short time the eggs are laid; they are firmly cemented to the substance on which they are deposited, and are not hatched in temperate climates until the following year. The object of the moth's existence being then accomplished, it shortly dies.

It has been remarked as an instance of the goodness of the Creator to man, that those animals most useful to him he has ordered should be the most easily managed; thus there is scarcely a caterpillar which could be reared by man with so small an amount of trouble as that which produces silk.

BUTTERFLY.—In this country the most common kinds of this insect are the large and small cabbage butterflies; both well known by the destructive effects of their caterpillars upon cabbage, brocoli, turnips, and other vegetables of the same kind. The caterpillar of the large cabbage butterfly is green, with three yellow lines running down the body, and is covered with black spots each having a single hair growing out of the centre. The butterfly which is first seen in April has two pair of wings, of which the foremost are white above tipped with black, and slightly yellow beneath; the hinder being powdered with black.

The small white cabbage butterfly does not appear until about May; its caterpillars are bluish green, and are too often to be found in the very heart of cabbages, cauliflowers, &c. Were it not for the immense number of caterpillars destroyed by the various small birds, their ravages would be excessive. They also fall a prey to a small fly that lays its eggs in the body of the caterpillar; these hatch into grubs, which feed on the fat of the insect, and eventually destroy it before it changes into a chrysalis.

Like all true insects, these animals undergo several changes during life. They are hatched from small eggs (which are laid by the perfect insect or butterfly); these give birth to the caterpillar, an animal having a long body formed of twelve rings united together, and furnished on each side with nine breathing pores. The bodies of some kinds of caterpillar are covered with hairs, those of others are naked. Each caterpillar is further furnished with sixteen feet, of these three pair near the head are horny; these afterwards become the six legs of the butterfly; the other five pair behind, being of no use to the perfect insect, are shed with the skin when the animal changes its state.

The head is small, and furnished with horny jaws which open sideways, and are well adapted for the devouring of their food. During the short life of the caterpillar it eats vora-

ciously, grows very rapidly, and sheds its skin several times; when full grown it ceases to eat, fastens itself by a silken thread it has the power of forming to some object, and there changes into a chrysalis: in this state it remains some time, and then bursts forth as a perfect butterfly.

The cabbage caterpillar usually attaches itself to a wall to undergo this change, and its appearance when hanging in this situation by its silken thread must be familiar to most persons.

The life of the perfect insect is but short, it flutters about in the summer's sun, alighting upon the expanded flowers, and feeding upon their honey, which it sucks up by its spiral trunk, unrolling it for that purpose; it lays a large number of eggs, and almost immediately after dies.

In consequence of the very great injury caused by these insects to the vegetables used as food by man, various means have been proposed for lessening their numbers, but the only effectual one seems to be the destruction of the caterpillars.

Cockchaffer.—The cockchaffer is a large insect of the beetle class, which are distinguished by having their thin and delicate wings concealed and protected when not in use, by two hard and horny wing cases. These latter in the cockchaffer are brown; the insect is also known by the extremity of the body being pointed, and by its short fan-like feelers.

During the day-time it is at rest in trees and hedges; after sunset it flies heavily with a loud humming noise in search of its mate, striking against various objects in its course; whence it is frequently termed the blind beetle.

The perfect insects feed on the leaves of trees, and they have been known to swarm in such immense numbers as to devour every green leaf over a large tract of country.

Their life in the perfect state is but short; the female lays a number of eggs six or seven inches deep in the ground, and then dies.

The eggs produce a kind of grub, termed, from the colour of the body, white worms. They have a small red head, and acquire when full grown the length of one inch and a half. They remain in the ground between three and four years, feeding upon the roots of various vegetables, and, where they are numerous, destroying the whole vegetation of a country.

During the ploughing season large numbers are eaten by the rooks, who may be observed following the course of the plough, and seeking for them in the newly turned earth.

These grubs also devour the roots of grass, thereby destroying the plants. In these cases the rooks may be observed to pull up the dead tufts of turf, for the purpose of obtaining the inseet; whence many persons have supposed that the rooks were destructive to the grass, instead of being, as they really are, exeeedingly beneficial.

During winter the grubs of the coekchaffer descend below the reach of the frost, to a depth of two feet from the surfaee; in the spring they again ascend.

The names by which the eockchaffer is known are very various in different parts of the country. From its eolour it is ealled brown beetle, and brown elock; from the noise with whieh it flies, miller; and from the time of its first appearanee, may-bug.

GRASSHOPPER.—Grasshoppers are well-known insects, remarkable for possessing in an almost equal degree the powers of flying and leaping. The body is thin, long, and flattened at the sides; the legs are six in number, the hinder ones being mueh larger than the others, and longer than the body. Eaeh hind leg consists of three distinct parts—the thigh, the shank, and the foot; these legs are not used in walking, but are only employed in leaping. When the animal wishes to leap, it draws the feet of the hind legs close to that part of the thigh that joins the body; the joint uniting the thigh and shank being bent to a very sharp angle, high above the baek of the insect; the various joints of the leg are then suddenly and powerfully strengthened, and the foot thus foreibly striking the ground, the animal is propelled high into the air.

The wings of the perfcet insect are thin and membranous; when at rest they are not to be observed, as they are folded up in a fan-like form under the narrow wing cases.

The ehirping noise made by the inseet is eaused by the rubbing of the thighs of the hind legs against the horny wing covers. The appetite of these insects is rather voraeious; they feed entirely on vegetable substances, such as herbage of various kinds.

The eggs of the female are deposited in the ground, and the young hatched from them resemble the old ones in appearance; but they are not furnished with either wings or wing covers, consequently they are unable to fly or chirp. After some time these parts grow, and the young then become changed into the perfect insect.

MISCELLANEOUS OBJECTS.

Bones.—Bones form the internal framework of the bodies of men, and of animals of the higher classes. In order to support the weight of the animal bones must be firm, unyielding, tough, strong, and able to bear pressing, pulling, or twisting, without being liable to bend or break.

To combine all these properties, so as to fit them for their office, the all-wise Creator has formed them of two substances, one of which gives them toughness, the other firmness.

If we burn a bone in the fire, nothing is left but a brittle earthy substance, which before the bone was burnt gave it firmness and hardness; whilst the substance that was destroyed in the burning resembled glue, and its use was to produce toughness and tenacity, with a little elasticity.

If bones were all earth they would be brittle, as is the case with the burnt bone. If they had no earth in them they would bend like gristle, and could not support the weight of the body.

Bones are of several uses to animals. 1st. By their hardness and firmness they give support and shape to the body. 2nd. They inclose and protect parts liable to be injured: thus the bones of the head protect the brain, and those of the chest the heart and lungs. 3rd. The bones keep the limbs firm, and enable us to move them at the joints or the places where they are connected together; and in order that the ends of the bones may move more easily and smoothly, they are covered with a smooth gristle, and kept moist by an unctuous fluid.

The long bones of the limbs are hollow, and are filled with an oily substanee which hardens when eold into marrow. The advantage of the bones being hollow is, that they are

lighter than if solid, and the same weight of bone is much stronger when hollow than it would be if formed into a solid body.

Bones are a very important article of commerce; the larger bones are used for various purposes, they surpass wood in hardness, and are not brittle. Tooth and nail brushes, knife handles, combs, paper knives, spoons, and a variety of small articles, are either turned or cut out of them.

The shavings and sawdust of bones formed in making these articles, is used under the names of ivory or bone dust for jelly.

If bones are heated in iron vessels they turn black, and in this state are termed bone black, or animal charcoal, which is much used in bleaching, and in clarifying sugar. (See Sugar.)

But the great use of bones is as manure; for this purpose they are collected from every part of this country, and even from the continent, taken to the bone mills and crushed, sometimes coarsely, sometimes to a fine powder. In this state the farmer either scatters them over his land, or sets a quantity with his seed.

The earthy matter of bones contains a large portion of phosphorus; this is extracted from them by a chemical process, and used extensively for the manufacture of lucifer matches.

Bristles.—Bristles are the strong coarse hairs from the backs of swine. They are very much used for the purpose of making the best kind of brushes, brooms, &c. Shoemakers also use them instead of needles in sewing the soles of shoes and boots. The thin or split end of the bristle is twisted with the end of the thread, and the stiff end is easily passed through the hole made by the awl, and the thread pulled after it. Needles would not answer for this purpose, as the force required to push them through the leather would break them.

The bristles used in England are chiefly brought from Russia and Prussia, about 2,000,000 pounds being annually imported to this country. Although the hog is entirely covered with bristles, yet those on the back only are of sufficient size and strength for use.

CORAL.—The various substances known to us by the name of coral, are the produce of certain animals inhabiting the ocean. Each of these animals has a cylindrical or oval body without a head; the body is hollow, and contains the stomach, which has but one opening, and this is surrounded by several feelers, arranged in a star-like manner around the mouth. The food of the coral animal consists of other small animals living in the water; when these latter approach within reach of the feelers of the former they are immediately seized, and forced through the mouth into the stomach.

These animals do not live alone, but in vast numbers together; growing like the separate buds of a tree upon a kind of stem, which is the substance we call coral. If a piece of white coral is examined, it will be found to be furnished with numerous holes, each of which was the habitation of a single animal. When undisturbed the animal comes out of its cell, moving its star-like feelers in search of food; but when alarmed, contracting within the cavity. All these animals are joined together by a thin fleshy skin covering the coral. As the number of the animals increases so does the coral branch out and grow, new cells being formed for the new animals. The coral is formed of lime chiefly, which the animals separate from the sea water.

Immense masses of coral grow together, forming rocks or coral reefs, which rise up to the surface of the sea. Sometimes these are near the shore, coasting the main land for hundreds of miles, as in some parts of Australia.

In other parts coral islands rise up to the surface of the sea, stopping at the top of the water; upon them sand and sea weeds are drifted; the latter, by their decay, form mould, in which seeds brought by the currents of the ocean grow, until at last an island is formed fit for the habitation of man. Numbers of the islands in the southern seas have been produced in this manner. One circumstance is requisite to the inhabiting these islands by man—namely, that fresh water should be readily obtained; it is, however, an extraordinary fact, that if wells be dug in the coral islands they are found to be filled with fresh water.

It is not by the growth of one kind of coral that these reefs and islands are formed, but by that of several.

Many kinds are brought to this country, all of them being

deprived of the animal forming them. The white coral has already been described; other kinds are yellow; but the most valuable is the red coral, prized from its colour, and great hardness, which enables it to receive a fine polish, and its freedom from pores or cells; its use for necklaces and other ornaments is well known. It is found in the Mediterranean Sea, in water of a moderate depth, and is obtained by divers.

When alive, the red coral is everywhere covered by a fleshy skin, upon which are placed animals like those before described; these when touched shrink back into the skin, but cannot penetrate the stem, as there are not holes for them.

Foot of Duck.—The foot of the duck is wonderfully formed to suit exactly the habits and wants of the bird to which it belongs. As the duck has to seek its food in water, it wants a foot capable of propelling it from one part of the stream to another; to answer this purpose we find that the foot is webbed—that is, a thin soft skin or web stretches from one toe to another, and unites them; when the duck, floating on the top of the water, wishes to swim forward, the webbed foot is pushed back against the water, and when the toes and web are spread out, the foot is large, and does not pass easily through the water, the body of the duck, which floats lightly on the top, is pushed on; the other foot is then used, and so on alternately as long as the bird wishes to swim forwards. After each foot has been struck back against the water, it has to be brought forward before a second stroke can be made; if it were spread out when brought forward, as it is when pushed back, the body of the duck would be pulled back again. But this does not happen, for when bringing the foot forward to make a second stroke, the duck closes it; the toes, instead of being spread out, fall together, and are bent, so that they offer scarcely any surface to resist the water; from this account it will at once be perceived how admirably the duck's webbed foot fits it for a waterfowl. When the bird wishes to swim towards one side, it strikes the water with the foot of the opposite side several times in succession.

Though this foot is beautifully formed for swimming, it prevents the animal moving rapidly on land; and its broad boat-shaped body, that enables it to float so lightly on the water, also renders its progress on the ground waddling and

unsteady: but its chief food is found in the water, and to that its formation is suited.

FEATHERS.—Feathers form the covering or clothing of the class of animals called birds. The importance of feathers to these animals will appear in the strongest light if we consider their habits. First, warmth is essential for birds; they are frequently exposed to great cold, as in the water, or when they ascend very high in the air, where the temperature is always low. Again, the heat of their bodies is greater than that of other animals, and requires to be kept up by a warm clothing. It is also necessary that their covering should be exceedingly light: if it were heavy and dense, it is evident it would unfit them for flight. Of the lightness of a bird's covering we may form a good idea when we find that the plumage of a common owl (a bird abundantly clothed) only weighs one ounce and a half. This lightness must be combined with great strength, as the feathers of the wings are the parts with which they strike the air violently to impel them in their flight. Lastly, their whole covering must be so smooth as to offer the least possible resistance to the air in their rapid passage through it.

On attentive examination we shall find that these requisites, warmth, lightness, strength, and smoothness, are combined in the covering of birds in a manner that proclaims the wisdom of Him who has declared in his word that without Him not a sparrow falleth to the ground. Every feather consists of three parts—viz., the quill or barrel, the shaft, and the vane or beard. The quill is that part of a feather by which it is attached to the skin; it is formed of a horny substance, which is of a hard and elastic nature, and is remarkable for being both strong and light. Lightness is given to the quill by its being formed in the shape of a hollow cylinder, which is filled with air; at the same time its strength is increased by this contrivance, for if the quill were formed of only the same weight of material solid, it would be considerably weaker. It is for this same reason that bones are hollow, that is, to ensure strength with the least possible degree of weight. That the quill may possess strength in all directions, it is formed of two sets of fibres (though, from their being transparent, this is not readily seen). One set runs the

length of the quill; it is this set that we tear apart (not across) when we split up a pen; the other set runs round these, and binds them tight together: if we do not scrape off the circular set before making a pen the slit is jagged, because we have torn these across violently. The membranous substance found within the quill is the dried remains of the pulp that originally nourished the feather.

The shaft of the feather is four-sided; it is largest near the quill, and gradually lessens in size to the end; it is slightly bent, to adapt it to the shape of the bird. It is covered with a horny substance like that of the quill, only not so thick, and is filled with a light elastic substance called pith.

The vane or beard of the feather is composed of a number of flat barbs, or pieces which grow from the sides of the shaft. They are placed with their flat sides towards each other, their edges being turned upwards and downwards; this method of placing them is the strongest that could be adopted, as it is their edges that strike the air when the bird is flying.

In looking at an unruffled feather, we may notice that the barbs or pieces of the vane are united together, and that they are not to be parted without some force. It is evident they do not adhere by any sticky matter, or the feather would feel clammy; and if we ruffle the barbs, and then smooth the feather from the quill to the end, they reunite. This reunion of the barbs after separation is effected by the following beautiful contrivance:—each barb has a set of tiny hooks springing from the top of each side; those from the side nearest the quill turn their points upwards, those on the other side hook downwards. When the feather is unruffled, these little hooks are all caught in one another, holding the barbs together; when the feather is ruffled by any force, they are torn apart, but not broken; for as soon as the sides of each barb are brought together by smoothing the feather, or by the bird's pruning itself with its bill, they reunite.

Perhaps some may suppose that the vane would have been better formed of one piece than of many barbs hooked together; but this is a mistake. Suppose the vane formed of one piece, and by any accident torn, it would not be in the bird's power to repair it; but if the barbs of the vane are ever so much ruffled, the bird has only to draw the feather a few times through its bill, and it again forms one firm flat body to resist the wind.

We often notice that the part of the vane nearest the quill is downy, and the barbs do not adhere together; this downy portion is next the skin of the bird, and serves to keep the body warm. From the top of the quill where it joins the shaft, a small tuft of down frequently arises; this is sometimes so large as to give the appearance of two feathers on one quill.

Feathers are often modified so as to suit the wants of the *particular* species of *bird*. Thus birds of prey, such as hawks and eagles, have hard firm feathers, extremely strong and elastic. Owls have soft downy feathers, so that they fly silently at night, and surprise their prey. The ostrich and other similar birds, that do not fly, have the barbs not joined by hooks, but loose and flowing. Swimming birds have their feathers close and oily, to prevent the water getting to their skin, &c.

The coverings of birds are of great use to mankind, and form articles of commerce, under the names of quills, feathers, and down.

Quills are chiefly used for the manufacture of writing pens, and are obtained from wings of geese; large numbers are kept in the fenny parts of England, and are deprived of the quills and feathers several times a year. The quills when pulled from the animals are sorted according to their size and quality; the smallest are sold under the name of pinions. Before they are sold for use, quills are frequently stained yellow.

The quills of other large birds are sometimes used for pens, but they are not equal to those of geese. The quills of swans are collected in Russia for making pens.

Feathers are used in this country for stuffing beds, bolsters, and pillows.

The most valued are obtained from geese, the inferior kinds from barn-door fowls, ducks, &c.

Down is the warm under clothing of many birds, the delicate and elastic filaments of which it consists are not hooked together like the barbs of feathers, but remain separate. Down is most abundant under the feathers of swimming birds, where it is requisite to prevent the water abstracting the heat of their bodies; consequently it is much more abundant on the under surface of the body than elsewhere, as in

many swimming birds that part is always in the water. The down of these birds is never wetted, as the close oily layer of feathers protects it from the water. The down of the swan is made into small tippets for the neck, &c., being preserved on the skin in the same manner as fur is. Some water birds, as the eider duck, pluck the down from their breasts to line their nests with ; this is collected by the natives of the frozen regions where the birds reside, and sold for a high price to stuff quilts, &c., for persons to sleep under in cold climates.

Fur.—Fur is the name given to the skins of animals in which the hair is very fine and close ; these skins, after being removed from the flesh, are dried without the hair being scraped off, sometimes by the aid of alum water, and at others merely stretched out in the sun. The use of the covering of fur to the animal is to protect it against the changes of temperature. Fur is a very bad conductor of heat, or in other words, it does not allow the warmth of the body to pass through it, so that the heat natural to the animal is kept from escaping. That benevolent care which is found everywhere in the structure of animals, is not in any part more evident than in their covering. The fur of all animals is suited to their habits, to the climate they inhabit, and even to the season of the year. If we examine a hare or rabbit in summer, and again in winter, we shall find that at the latter season it is thicker and closer, much warmer, and therefore better suited to the cold of the season, than if only of its summer thickness. So well are the fur dealers aware of this fact, that they only pursue the animals yielding fur in the winter; and even our own hare skins are worth much less in warm than in frosty weather. God's care of the animal does not consist in merely thickening the fur; in many instances he has so wisely ordered it, that with the approach of cold the fur changes colour, passing from the summer colour of the animal to white. This is the case with the hare in the north of Scotland, with the stoat in this country, and with almost all the animals in the cold polar regions. At first sight this may seem anything but a wise provision, for we all know that in summer dark clothes are warmer than light ones, as they absorb more rapidly the warmth of the sun; but in extreme northern climates the sun has very little power in winter, and

the light coloured fur of the animal prevents the escape of its own warmth much more completely than a dark coloured fur would do. Another advantage the animal gains by its change of colour is, that when the ground is covered with snow, the small quadrupeds are much less easily discovered by their numerous enemies, as hawks, owls, &c., and so more readily escape destruction. It should be borne in mind that the change of colour does not take place by the dark hairs falling out and being replaced by light ones, which would expose the animal to severe cold, but the fine hairs of the fur remaining on change colour. So rapidly will the fur become white, that it has been noticed that all the hairs on an animal have changed by a week's exposure to severe cold. Man, observing how completely animals are protected by their warm coverings, has long been accustomed to adapt them to his own use, more especially when he resides in cold climates. Many thousand animals are annually destroyed, their skins dried with the fur on, and then used for clothing. In cold climates the garments are frequently made or lined with fur; in this country they are only used in winter, and then partly for ornament. The principal furs used for this purpose are those of the hare, rabbit; the ermine, which is merely the skin of the stoat in its winter dress; various squirrels, sable, fitch, or polecat, &c. &c. The fur of the beaver, the hare, rabbit, and some other animals, is also used for the purpose of covering beaver hats and bonnets, being cut off the skin and fastened by varnish or glue upon the body of the hat.

Glue.—Glue is an animal substance much used in the various arts as a strong cement. The best is obtained from the skins of animals, the small cuttings of which, rejected by the currier, being generally employed. An inferior glue is made from the sinews and hoofs of animals.

These materials are first well washed in lime water, which assists in removing any grease; they are then boiled in water until all the soluble parts are dissolved; the impurities that rise to the surface are skimmed off; the liquor is then strained to separate it from the undissolved pieces of skin, and lastly boiled down until it becomes on cooling a very firm hard jelly. This jelly is cut into thin flat square

pieces, which are dried upon coarse netting; the depressions left by the network are always visible on the dried glue,

When of a good quality, glue is of a deep rich brown colour, semi-transparent, and without spots or clouds in its interior; and it should be perfectly soluble in water, not leaving any sediment. The solution of glue in water is, when cold, a jelly-like mass, which varies in firmness with the quantity of glue dissolved; even when made very firm it readily melts with heat, and it is in this state that glue is used as a cement. It is applied whilst hot to the substances which it is wished to unite; they are then pressed together, and as the glue becomes firm on cooling they remain cemented, although it is not till after some days (when the glue has become perfectly dry) that the joint is very firm.

The use of glue depends upon its being so readily soluble, especially in hot water, its adhesiveness when dissolved, and also upon its becoming solid as it cools and dries. Its tenacity when used as a cement is very great; frequently the wood-work joined by it will break at some other place, and not at that at which it is cemented. Glue is useless in damp situations.

In order to prevent the glue from being burnt in heating, the carpenter employs a vessel called a glue-pot; this consists of two vessels, one placed within the other. The outer one, which is much the larger, is partly filled with water, whilst in the inner one the glue to be dissolved is placed. Its use is evident, for as long as any water remains in the outer vessel the glue cannot be burnt.

The workmen using glue are chiefly carpenters, joiners, and cabinet makers; a weak solution of it resembling jelly in appearance, is much used by whitewashers in order to prevent the whiting from being readily rubbed off when dry.

Isinglass, so much used for making jellies for eating, is only a purer kind of glue obtained from the air-bladders or sounds of several kinds of fish. And a pure kind of glue is obtained from the skins of animals, and sold under the name of *gelatine* for the same purpose.

Hen's Foot.—The fowl belongs to that class of birds which in a natural state seek their food (which consists of insects,

grubs, and seeds) in the ground; to enable them to do this, they are formed with exceedingly strong legs and feet, and toes furnished with stout blunt curved claws. The feet are used for scratching up the loose surface of the earth, the bird supporting itself on one leg, and scratching powerfully with the other. The claws grow very quickly, so that they are of a sufficient length to be serviceable to the animal.

As these birds have to seek their food on the ground, they do not greatly want the power of flying, the strong legs that serve them for scratching give them the ability of running very fast, and of moving readily from one place to another in search of food.

Horn.—The substance known as horn is yielded by a large number of ruminating animals; as, for instance, by the ox, the goat, the sheep, and the antelope. The same term is often applied to the antlers of the stag or deer tribe; but very erroneously, as these latter consist not of horn but of solid bone, are generally branched, and are also shed annually, whilst true horns are permanent. The horns of the ox, &c. are of a conical form, and generally somewhat curved. They are formed of a bony core in the centre, which rises from the bone of the forehead; this is supplied with nerves and with the vessels which form the horny portion that surrounds it like a sheath.

Horn, like the nails of the fingers, is quite insensible—the tip may be cut off without giving pain; but if the bony core be injured, it bleeds freely, and the sufferings of the animal appear very great. The chief difference between horn and bone is, that the former is destitute of earthy matter; hence arises its semi-transparency.

The horns used in manufacture are obtained chiefly from the bull and the cow; so great is the demand for them in this country that they are brought here in large numbers from Russia, the Cape of Good Hope, and South America.

Horn is prepared by first soaking it in water for five or six weeks; this loosens the core, and it can then easily be pulled out from the true horn. The solid part of the horn, near the tip, is then cut off, and preserved to be used in making knife-handles, buttons, &c.; the remainder is softened by boiling water, and exposure to the flame of a fire. In this state

it is slit with a knife, and pressed flat between hot iron plates. If required for thin sheets for lanterns, it is pressed with great force, then split into thin layers, smoothed by scraping, and afterwards polished.

When prepared for combs, the horn is slightly pressed and cut into the required shape by a saw and rasps; the teeth are then cut by a saw, and finished by rasping.

If a very large piece of horn is required for a comb, or any other article, two pieces are joined together by heating the edges until they are quite soft, and pressing them together firmly till they are cold.

Drinking cups are formed by moulding the hollow part of the horn (softened by heat) into a regular shape—it is then polished. A deep groove is afterwards cut or turned near the bottom; it is again softened by heat, and a flat piece of horn, of the proper size, forced into the groove. The cup contracts as it cools, and the joint is perfectly water-tight.

Horns were anciently used in making the musical instrument so called: the name still remains, thus we have the bugle-horn, &c.

Horse-Hair.—By this name is generally meant the hair of the tail and of the mane of a horse.

The long hair of the tail is woven into a kind of coarse cloth for sieves; also into a fabric for covering sofas, chairs, &c.; but in this case the horse-hair only runs in one direction, and threads of flax or hemp in the other, so strong and firm as to give great strength to the whole.

The long hairs are also used to form fishing-lines and violin-bows.

The inferior and shorter hair is used for stuffing matresses, sofas, &c. To fit it for this purpose, it is baked with a gentle heat, by which it is rendered much more elastic than before.

The short hair of the mane is used for stuffing horse collars, and for very inferior work.

Ivory.—Ivory is the name applied to the bony substance forming the teeth of various animals, as the hippopotamus, walrus, and elephant; though, usually, those of the latter alone are meant. It is the tusks of the elephant which furnish this substance—the grinding teeth are formed of various

hard substances, not at all resembling ivory; these tusks usually weigh, each, from fifty to seventy pounds, and sometimes they are even much larger. When cut, the inner part of each tusk is found to be white, of a very fine, close grain; extremely hard, and yet elastic—slightly compressible by great force. When cut into thin sheets, it has a degree of transparency greater than paper of the same thickness. Its use in the arts depends on its possessing various properties. From its white colour and semi-transparency it is used in thin sheets to paint miniatures upon. The turner employs it for various small articles, on account of its beauty and hardness, whilst its elasticity and closeness of texture render it much less liable to crack than bone. Dentists use the various kinds of ivory for making artificial teeth: the qualities of hardness and whiteness again recommending it.

Ivory is composed of the same kind of material as bone (see Bone), viz., an earthy substance and glue; hence, the small fragments and powder formed in turning, filing, and working ivory, are sold under the name of ivory dust, for the purpose of making jelly; as, when boiled for some hours in water, the gluey portion dissolves and forms a nutritious jelly, fit for food.

Leathers, various.—*Sole leather, upper leather, morocco leather, glove leather, and wash leather.*—Leather is a substance universally used amongst civilised, and very generally among barbarous, nations. It is made from the skins of animals, which are tanned and prepared with some substance having the power of changing the perishable skin, that decays readily when wet or moist, into a lasting and comparatively imperishable leather.

As leather is prepared from the skins of different animals, and is required for various uses, several tanning substances are used, according to the kind of leather required; that for the soles and upper leathers of men's shoes, for harness, and such like purposes, is prepared and tanned, as it is termed, with the aid of oak bark. The hides or skins, either fresh, as received from the butcher, or salted, as they are brought from abroad, being spread out, the small pieces of flesh on the inside of the skin are removed; the hide is then soaked

in lime-water, by which means the hair is loosened, and can be readily scraped off. Thus cleansed from the hair and flesh, it is soaked for some days in sour water, made so either by putting barley or rye flour into it, which remains till it becomes sour, or by adding a small quantity of oil of vitriol. This acid solution has the effect of opening the pores of the skin, so that the tan can afterwards penetrate into it more readily. The hide is then placed in the tan-pit along with oak bark and water; it is first placed in weak, and lastly in strong tan. Sometimes the hides and powdered bark are laid in layers one over the other until the pit is full. The process of completely changing the skin into leather is a very slow one. To make strong and well-tanned leather, the hides remain in the pits from six to twelve, or even to eighteen months. If the hides are taken out too soon, the middle of the skin is not tanned. The hides, being removed, are dried, and then passed between rollers, which gives them a smooth surface, and renders them firmer.

By these processes the skin is much altered in its properties; when it is taken from the animal it is soft and moist, but when it becomes dry it is brittle, and liable to crack, and very perishable, putrefying rapidly if kept wet: these qualities prevent untanned skins being of much use to man. Leather, on the contrary, is flexible and soft, whether it be wet or dry; it is, if properly prepared, water-proof and lasting, not decaying when moist; at the same time it is light and sufficiently strong to stand much wear when made into shoes, harness, &c.; for which purpose these properties render it better fitted than any other material known.

The leather required for the upper leather of boots, &c. is sent from the tanner to the currier, who, by rubbing and paring it down, renders it more flexible, softer, and capable of being polished; at the same time he blackens it with lamp-black and oil, or tallow. The skins used for upper leathers are calf, and the thinner skins of cows and horses; whilst the thicker ones, of oxen, &c., are made into soles.

Other kinds of leather, required for different purposes, are made by slight variations in the process.

Morocco leather is prepared from goat skins, which are imported into this country. The flesh and hair are scraped off as

before described; each skin is then sewed into the shape of a bag, which is filled with a vegetable substance termed sumach, and water; this, like the oak bark, is astringent, and it has the effect of tanning these thin skins in a few hours; they are then dyed of the colour required, and rubbed over with a grooved ball in order to give them the grooved appearance which distinguishes morocco leather. Imitation or inferior morocco is manufactured from sheep skins. As thus prepared, morocco leather is soft, and very flexible, from the rubbing it receives, whilst its grooved appearance renders it very beautiful. When dyed it is frequently chosen for covering books, for chair-covers, and lining carriages, &c.

The thin leather, which from its softness and capability of yielding or stretching, is usually selected for gloves and ladies' shoes, is tanned with alum, after the skin has been scraped free from flesh and hair. In order to render this kind of leather as soft and yielding as possible, it is, during the process, prepared with eggs and flour. Although the gloves and shoes made with it are termed kid, yet the skins used in the preparation are chiefly those of lambs.

The only other kind of leather to be mentioned is that termed wash, or shamois leather. In order to prepare it the skins are cleaned with lime, dried, and then beaten with heavy hammers, being kept wet with oil; they are then hung up to dry, again beaten with the addition of fresh oil; and this operation is many times repeated. The excess of oil is then removed by soaking the skin in water containing pearl-ash; it is afterwards dried, and is then fit for use. Being exceedingly sofft, it is much employed in polishing metal articles; and, from its warmth and softness, it is frequently made into under waistcoats, &c. It does not resist the wet, and is therefore unfit for outer clothing.

Milk.—Milk is the fluid with which the young animals of the class of mammals or quadrupeds are nourished.

It consists of several distinct substances, which separate from one another on its being allowed to remain undisturbed: these substances are cream, curd, and whey. The cream is obtained by allowing the milk to stand in shallow pans twelve or more hours, when it rises to the surface, and is readily removed. What remains is called skim, or skimmed milk; if

this is allowed to stand some time it becomes sour, and the curd, or solid part, separates from the whey.

In this country the milk of cows is that most generally used for food; and, besides being most extensively employed in its fresh state, it is in great demand for making butter and cheese.

Butter is made by collecting a sufficient quantity of cream, which is placed in the churn, a wooden tub, wider at the bottom than at the top, and covered by a round lid with a hole in the centre, through which a handle passes, that is fixed to a round flat board with several holes in it. The cream, which fills two thirds of the churn, is violently agitated, by the handle being moved up and down. In the course of an hour's churning small lumps of butter appear, which soon unite together into larger masses. When the butter is formed, it is taken out of the churn, washed, and pressed, and (unless used fresh) is salted and casked for use. The liquid part of the cream left in the churn after the butter is removed is called butter-milk, and is chiefly used for feeding pigs.

Cheese is the curd of milk pressed and dried. The curd may be separated from the whey by allowing the milk to become sour; but the cheese so produced is inferior in quality. In this country rennet is added to the milk to curdle it; this rennet is a fluid prepared from the stomach of a sucking calf. The curd formed by the rennet is separated from the whey, salted, and strongly pressed into a shape; it is then dried, and is ready for use. The richness of cheese depends on the milk from which it is made. Skim milk makes poor hard cheese; whereas, if an extra portion of cream be added to the milk, as is done in making Stilton cheese, the quality is much improved. It is often the practice to colour cheese; this is done by adding a dye called annatto to the milk.

Although in England the use of cows' milk alone is general, in other countries that of different animals is used; as, goats' milk in Switzerland, reindeers' in Lapland, camels' in Arabia, and mares' in Tartary.

The milk of the ewe contains a much larger quantity of cream, and is richer than that of any other animal that has been examined.

That of the ass contains no cream, and is therefore drank by invalids, with whom oily substances would disagree.

PARCHMENT.—Parchment is a writing material made of the skin of sheep or goats. The skins are first prepared by the leather-dresser, in the same manner as if they were to be formed into leather (see LEATHER), being soaked in lime to remove grease and loosen the wool, which is afterwards scraped off. They are then very tightly stretched, either over a hoop or by means of a strong wooden frame; then, with a large double-handled knife, the skin in scraped, or pared down on both sides, and all irregularities of the surface are removed, when it is ground, or rubbed smooth with pumice stone and chalk, or lime; it is then allowed to dry slowly, and is again scraped and ground with smooth pumice stone until it is reduced to the requisite degree of smoothness.

As thus prepared, the chief use of parchment is for writing upon, it being much stronger and less liable to injury than paper, and being less perishable. For this reason all legal writings, such as wills, leases of houses and land, are written upon it.

It is also used for drum heads, for binding books, &c.; but in these cases a stronger substance is required, and the skins of asses, calves, &c. are employed instead of those of sheep.

SOAP.—This useful substance is of great antiquity. In excavating the city of Pompeii, which was buried by an eruption of Mount Vesuvius, about 1700 years ago, a soap-maker's shop, containing soap, was discovered. In the Old Testament it is referred to in Jer. ii. 22, and Mal. iii. 2; but it is thought that what is there alluded to is the ashes of some plant.

The whole of the various hard soaps used by us are prepared from different kinds of fat, or oil, and the alkali soda (see SODA). It is necessary, in order to prepare soaps, that the common soda should be rendered much more caustic than it is in its usual condition; this is done by boiling it with lime fresh burnt, which, acting chemically on the soda, greatly increases its caustic powers. The soda thus prepared and dissolved in water, forms what is termed the lye or ley

of the soap-boiler. The soap called mottled is manufactured in the following manner. In a large iron vessel, heated either by steam or a fire, is a large quantity of melted tallow and kitchen grease; into this a quantity of the ley is poured, or pumped. The mixture is boiled for some time, and frequently stirred, during which time the tallow, &c. unites with all the soda of the ley, leaving the water, which is then pumped away, and a fresh supply of it poured in; this is repeated as often as is required, until the whole of the tallow and grease is changed into soap. The mottled appearance, from which this soap has derived its name, is caused by a small quantity of very strong ley being sprinkled on the surface; this sinks in, and marbles, or mottles, the soap. In order to cool and harden the soap it is removed from the boiler and poured into large pans; and when become a solid mass, is removed, and cut up by wires into the bars in which it is sold.

Curd soap is made in nearly the same manner, pure white tallow, without kitchen grease, being used. When scented, and cast in small cakes, it is sold as Windsor soap.

Yellow soap is made with resin and palm oil instead of tallow. It is the resin that gives it the peculiar smell and bitter taste it possesses.

Soft soap is made with pearlash (see PEARLASH) instead of soda, and whale or seal oil used with the tallow.

All the various soaps are soluble in water, forming semi-transparent solutions. If the water containing soap be shaken, or agitated, it retains on its surface the bubbles of air; it is then said to lather.

When wet, or dissolved, soap has a peculiar feel, which is so unlike that of other bodies that it is distinguished by the term soapy. The great use of soap depends upon its dissolving in water, and upon its power of removing grease and dirt. This effect is owing to the caustic alkali it contains. It may be asked, would it not be better to use the caustic soda by itself, instead of mixing it with tallow? It would not, because its action would be too violent—it would burn and destroy; whereas, when made into soap, it retains much of its power of purifying without any of the destructive effects of its caustic nature.

SPONGE.—The substance so well known by this name is an animal product, which is found attached to the rocks under water in the Mediterranean and other seas.

Sponge is a light, soft, and highly elastic material, very easily compressed, and rapidly resuming its original shape when the pressure is removed. It is exceedingly porous, containing an immense number of small tubes, which communicate with some larger apertures that are found in it. The substance of the sponge consists of horny elastic fibres, and these are so placed as to form the tubes and pores described.

When the sponge is in the sea, alive, the inside of the pores are covered with a soft substance, like white of egg. This appears to be the flesh of the animal, and currents of water may be seen running into the sponge through the small pores and out of it through the large ones; and it is supposed that whilst the water is passing through the sponge, the nourishment requisite for the support of the animal is extracted from it.

When the sponge is removed from the water, this soft flesh drains away, leaving nothing but the elastic fibrous substance with which we are acquainted.

The use of sponge, as a material for washing with, depends, chiefly, on its being so highly porous and elastic. When placed in water its pores become filled with the liquid. If in this state it is compressed, the water is readily forced out over any thing it is desired to clean, and as soon as the pressure is taken away the sponge resumes its former size, and its pores are again open to suck up a fresh supply of fluid, if required.

The sponge we use comes from the Mediterranean Sea, where it is procured by diving, and also by dredging, or dragging the bottom of the ocean. The best sponge, which is white and fine, comes from Turkey; the inferior and coarser kinds from the coast of Barbary. Ten or eleven kinds of sponge are found on the coast of our own country—none of them are fit for use.

TORTOISESHELL.—This beautiful substance is produced by a sea tortoise, or turtle. The animal from which the tortoiseshell of commerce is obtained is the hawksbill turtle, a native of the seas of the torrid zone.

Its usual length is about three feet. As in the other animals of the order to which it belongs, it is enclosed in a bony case, formed underneath by the expanded breast-bone, and on the back by the flattened ribs and spine; on this bony arch grow the scales of tortoiseshell. In the hawksbill these scales of the back are thirteen in number, besides twenty-five small ones at the edge; they overlap one another to a great extent, and are thick in proportion to the size and age of the animal.

The plates or scales are readily removed from the bony arch by heating it over a fire; this process loosens them, and they are easily separated by passing a knife under them. The value of the rough shell is very considerable, the best being worth about three guineas a pound. Frequently it is injured by barnacles, limpets, and other shell fish fixing themselves to the turtle whilst alive. Tortoiseshell is manufactured in a similar manner to horn, a substance which it closely resembles. It is first softened by boiling in salt and water, and is then pressed flat until cold; it is rendered smooth and of uniform thickness by scraping and filing; and if larger pieces are required than can be obtained from single plates, two or more pieces are united together in the following manner. The edges to be joined are sloped off to the distance of about a quarter of an inch from the edge—the margins are so placed as to overlap one another, and pressed together by an iron press—the whole is then placed for some time in boiling water; the two pieces by this means become so perfectly united that the joint cannot be seen. The filings and powder of the various processes are not lost; they are collected and placed in moulds, made of metal, and by the action of pressure and boiling water are formed into any shape that may be desired. As heat is likely to darken the tortoiseshell, and greatly lessen its beauty, it is usually cut into the required patters by drills and saws, instead of being moulded like horn.

In making small combs, in order to save the tortoiseshell, two combs are formed out of one piece; the teeth of one comb being cut out of the spaces between the teeth of the other. Besides its use for combs, boxes, &c., tortoiseshell is also used for inlaying and ornamenting tables, cabinets, &c. For this purpose it is cut thin, and a bright metal is placed

underneath it; this, shining through the thin shell, gives it a brilliant appearance.

Whalebone.—This peculiar substance is not, as its name might seem to signify, obtained from the bones of the whale, but from what forms a substitute for teeth in the Greenland whale, and the kinds more nearly resembling it.

The lower jaw of this animal is very large and spoon-shaped. It is totally destitute of teeth, or any thing resembling them. From the sides of the upper jaw (occupying the usual situation of teeth in other animals) hang the plates or blades of whalebone, about three hundred in number on each side; they are flat, and ranged parallel to each other at right angles to the jaw. Their points and edges next the inside of the mouth are coarsely fibrous, so that they form a sort of strainer, or filter, the lower ends of the plates being enclosed within the capacious lower jaw. The blades are the longest at the middle of the jaw, and gradually decrease in length towards each end. The usual length of the longest plates is about nine feet, though they sometimes attain that of fourteen or fifteen feet.

The surface of each blade is firm and very compact, and can be readily polished. This substance is easily split in the direction of its length. In the centre, between the two surfaces, it is less compact, being more fibrous, and the point and inside edge are so coarsely fibrous as to form a kind of coarse fringe.

The use of this apparatus to the whale is very great; it is the only means it possesses of securing its food; for although this creature attains the immense length of fifty-five to sixty-five feet, and a girth of thirty or forty feet, with a weight equalling that of two hundred oxen, it feeds entirely on the small pulpy animals that float in countless multitudes in the water of the arctic seas. In order to secure these it swims with considerable rapidity, the mouth being open. The water rushes in at the fore part, where the plates of whalebone are absent, and passes out at the sides, being strained through the fringe or filter above described, which allows the water to escape, but retains the food of the whale. The passage to the stomach of the animal is of very small size, so as to prevent it from swallowing even the smaller fishes.

The quantity of whalebone yielded by a Greenland whale of full size is about one ton. In colour it is generally dusky greyish black; some pieces are partially, or even wholly white. The first step in the preparation of whalebone is to boil it for some hours in water. This operation renders it soft, and more readily cut; but when it has become cool again, after boiling, it is harder, and of a darker colour than it was before.

Whalebone is used for various purposes. It is split into fibres, which are used instead of hair in making coarse brooms and brushes. It is also employed in great quantities in the manufacture of the stretchers for umbrellas and parasols, for which purpose it is well fitted, by reason of its great elasticity. It is also employed for stiffening women's apparel and is platted into riding-whips.

The white pieces are sometimes cut in thin strips and made into bonnets, and even, after dying, into artificial flowers.

TEXTILE OR WOVEN FABRICS,

AND THEIR MATERIALS.

NOTE.—The materials from which our clothing is derived are obtained from both the animal and vegetable kingdoms; it has, however, been thought better to unite the descriptions of them under one head, as the processes they undergo in the course of manufacture are very similar, and needless repetition will be avoided by such an arrangement. The same reason has led to the insertion of a short account of the processes of spinning and weaving.

Spinning.—This process, which consists in uniting the loose fibres of cotton, flax, or wool, &c. into a thread fit for the use of the weaver, is of the greatest antiquity; it is alluded to by Moses in Exod. xxxv. 25, and was at that time evidently an old art. Originally it was performed with the distaff and spindle; the former was a stick about a yard long, with a knob near one end. Around this the flax or wool previously combed, so as to lay the fibres parallel, was loosely twisted. Thus charged, the distaff was held under the left arm, some of the fibres being pulled out by the thumb and fingers of the right hand, and twisted into a thread, which was wound upon the spindle, a rod of wood about a foot in length, having a slit at one end in which the thread could be caught; the other end of the spindle was fastened to a piece of stone or metal to increase its weight; this enabled the spinner to keep it spinning round as it hung by the thread, whilst the fingers were pulling out fresh fibres from the distaff. As soon as the spindle reached the ground, the thread was taken out of the slit, wound on it again, fastened, and a new length commenced. Distaffs and spindles are still used by the peasants in some of the most remote parts of Ireland.

This process of spinning was at length superseded by the use of the spinning-wheel; the cotton or wool, first combed or carded, so as to lay the fibres parallel, is attached to a spindle so fixed that it is made to turn with great rapidity by a strap of leather passing over a large wheel, which in its turn is caused to revolve by the hand or foot of the spinner.

At the present time the spinning-wheel is almost as rare to be seen as the distaff and spindle, all the varieties of clothing being now woven from thread spun by the aid of powerful and complicated machinery, which acts upon the same principle as the spinning-wheel, although far too intricate to be understood without the aid of a long description aided by numerous illustrations.

Weaving.—Weaving, or the art of making cloth by the interlacing of threads, has been practised from the earliest times. Upon the tombs of the ancient Egyptians are found paintings of looms constructed on the same plan as the hand loom of the present day; and these were in use in the time of Joseph.

If we examine a piece of any plain woven material, as calico, silk, &c., we find a number of parallel threads running longitudinally the whole length of the cloth; these threads are called the warp. There are also cross threads which pass alternately over and under the threads of the warp; these threads form the weft.

In weaving, the first process is to fix the threads of the warp; in a common loom these are wound as evenly as possible upon a cylindrical beam or roller; a kind of comb being used to lay them parallel, and spread them to the required width of the cloth; the warp is then partly unrolled, the ends being fastened to another roller. In order to separate the threads of the warp, so that the thread of the weft may pass alternately above and below them, the contrivances called heddles are used; each heddle consists of two horizontal sticks, one placed a small distance above and across, the other below the warp. These two sticks are connected together by a number of small threads passing from the one to the other, perpendicularly through the threads of the warp; in the middle of each thread of the heddle there is a little eye or loop, through which every alternate thread of the warp is passed,

whilst the remaining threads of the warp are passed through the loops of the other heddle.

Each heddle is so fastened that it may be raised up or pulled down about two inches by a treadle moved by the feet of the workman. Now it is evident that if one heddle be pulled up and the other down, half the threads of the warp will be raised, and every alternate one depressed, leaving a space between them through which the thread of the weft can be passed, when it will be over half the threads of the warp and under the other half. If the heddle that is pulled up is now pulled down, and the one that was down pulled up, the position of the threads of the warp is reversed; and if the weft thread be then passed between the two layers, it will be under the threads it passed over before, and over those it was under. As it would be difficult to pass the thread of the weft by the hand, it is wound on a small piece of wood called a shuttle, which is thrown across the warp, and the thread unwinds as it proceeds.

In weaving by hand, the weaver sits at one end of the warp with a foot on the treadle of each heddle, and then takes the shuttle in one hand; he then raises one heddle, by which half the threads of the warp are raised, the other depressed. Through the opening between the threads he throws the shuttle right across from one side to the other: then with a contrivance called a batten, which is like a large comb, he forces the thread of the weft close up to those previously woven. Then, taking the shuttle in the other hand, he raises the other heddle, which reverses the position of the threads of the warp, and throws the shuttle back again; the thread of the weft is then pulled up by the batten close to the last thread, and the process is continued until the whole of the warp is made into cloth by being crossed by the thread of the weft. As the cloth is woven, it is wound upon a roller, so as to be out of the way of the weaver.

In this manner what is called plain weaving is conducted, and some slight variations of the process will be noticed under the heads of the different fabrics described.

The hand loom, as the instrument is called, which has been described, is rapidly giving place to the employment of the power loom, in which the various movements described are all accomplished by the force of the machinery, which is

moved by steam engines. The principle, however, is the same.

Raw Cotton.—This extremely valuable substance is the produce of the cotton tree, a plant of which there are several varieties; some distinguished by being annuals, whilst others are shrubby and attain the size of a small tree.

The leaves are deeply notched, or divided into several lobes. The flowers are large, of a sulphur yellow colour, and resemble in formation and appearance those of the single hollyhock; each flower is succeeded by a brownish seed-vessel, which is surrounded by three heart-shaped leaves, toothed at the edge. This seed-vessel when ripe bursts open, and discloses a mass of snowy white cotton, amongst which are the seeds. One variety of cotton much cultivated in China has the yellow tinge that is preserved when woven into the cloth called nankeen. The cotton plant is largely cultivated in India, China, in the United States of America, the West Indies, the shores of the Mediterranean, and almost all the warmer parts of the world.

Whatever variety is cultivated, the cotton is picked out of the open pod whilst the plant is standing in the ground; that portion only being selected which is ripe. It is dried in the sun; and the next object is to separate the seeds, which would otherwise injure the cotton, they being oily. In India this is done by means of two rollers, which are so fixed in a frame as to turn round together, leaving a small space between them; the cotton is drawn through by the turning rollers, but the seeds, being too large to pass, are torn off and separated. But this machine will only free from the seeds about forty-five pounds of cotton in a day; therefore another process is adopted in America. The cotton is placed in a kind of box, one side of which is formed of a grating of strong parallel wires about one-eighth of an inch apart. Close to this box is a roller bearing a number of circular saws, the teeth of which pass through the grating into the box. When the roller is made to turn rapidly, the teeth of the saws drag the cotton through the wire, whilst the seeds, being too large to pass, remain behind. Thus separated from its seeds, the cotton is pressed tightly in bags, and is brought to this country under the name of Raw Cotton.

The manufacture of raw cotton into calicoes and other fabrics is now entirely accomplished by the aid of complicated machinery, the description of which could not be followed without the aid of numerous engravings, which would be useless in a work of this nature; therefore merely the name and use of each process will be mentioned, without a lengthened account.

In the first place, the cotton is picked by hand, so as to loosen its fibres and free it from dirt. This operation is completed by a machine called a willow, in which the tufts of cotton are torn into separate fibres by rapidly revolving iron spikes. These loose light fibres require to be laid parallel before spinning; this is effected by the carding machine, in which the cotton is passed between what may be likened to two *brushes* of iron wire: these have the effect of laying all the fibres parallel, when they are transferred to the spinning machine, of which there are various modifications, but the effect of all is to form a slight thread fit for the use of the weaver. This is made to vary according to the purpose required; some yarn (as the spun cotton is termed) being fine, for muslin and lace; another kind strong, for coarse work; a third is retwisted, two or three threads together, so as to make the strong and firm material known as sewing cotton.

FLAX.—The plant known as the common flax is a native of this country, and is found abundantly in many other parts of the world. The variety most commonly cultivated is an annual, with slender green herbaceous stems one foot and a half or two feet in height, bearing narrow pointed leaves without stalks, and terminated by elegant blue flowers; each of which is succeeded by a capsule or seed-vessel, containing ten flat oblong seeds of a brown colour. The flax plant is cultivated for two purposes. When the fibres of the stem are required to form lint, or the material of linen, the seeds are thickly sown, so as to cause the stems of the crowded plants to run up high and thin. When the seeds, which are called linseed, are the principal object, the seeds are sown less thickly, and the plants are allowed to remain longer in the ground before reaping.

When ripe, the leaves fall off and the stems turn yellow; the flax is then pulled out of the ground by handfuls; care-

fully dried in the sun, and then either stacked or stored in barns until the next year, or stripped of its seeds at once, by drawing the ends through an iron comb fixed upright in a block of wood. The seed-vessels, being too large to pass through the teeth of the comb, are torn off, and fall into a basket below; sometimes they are separated by beating. As thus obtained, linseed, or the seeds of the flax, are extremely valuable in the arts from the quantity of oil they contain; in order to extract this for use, they are crushed by immense pressure, and the oil forced out. If they are slightly heated by steaming before being pressed, they yield a larger quantity of oil, although it is rather injured in quality by the warmth. From 100 pounds of linseed are usually obtained twenty-three or twenty-four pounds of oil.

Linseed oil is one of the cheapest and most useful of our vegetable oils; it is used in large quantities by painters and glaziers, for making paint and putty. and is also employed for other purposes in the arts. Though not unwholesome, it soon becomes rancid and nauseous to the taste; therefore it is unfit for the food of man.

The crushed mass that remains after the oil has been pressed from the seeds, is extremely nutritious, and is much used for fattening cattle under the name of oil-cake.

The skins of the seeds contain a large quantity of mucilaginous or gummy matter, and when boiling water is poured on to them this substanee is dissolved, and the solution is called linseed tea. If care be taken that the seeds be not broken, it is quite free from any oily taste.

The seeds ground into powder form what is called linseed meal, a substance much used in medicine, for poultices, &c.

The stems of the flax plant freed from the seed undergo a series of processes to prepare them for the use of the weaver. They are first steeped, or partially rotted in shallow pools of water, in order to cause the fibres of the bark (the part employed) to separate readily from one another; the stems are then dried by being spread out upon grass and exposed to the sun and air for about a fortnight. The next process removes the central woody portion of the stem, which has been rendered brittle by the steeping the flax has undergone; the instrument used is called a brake. The simplest is a piece of wood, having a long slit in it, and raised on a stand; into

this slit a blunt wooden sword fits loosely. If a bundle of flax be laid over the slit and the sword brought down upon it, the woody brittle part of the stem is broken by being bent as the sword presses it into the slit. In general the brake is made of three swords fixed to one handle, and so arranged as to pass between the edges of four others fastened in the frame; thus the flax is broken in four places at once. In some parts of England the flax is beaten with a mallet to break and separate the woody portion of the stem. After being thus broken, the pieces of the wood are beaten out from amongst the fibres by a flat wooden staff, or sometimes rubbed out by hand; at the present time, in England, both these operations are performed by machinery.

In order to fit it for the use of the spinner and weaver, the flax has now to undergo the process of heckling, the object of which is to comb out the short, useless fibres, and lay the long ones parallel. The heckle consists of a piece of wood thickly covered with metal points about one or two inches long, so that each heckle may be compared to a brush made of sharp-pointed needles instead of bristles; of these heckles, some are coarse, others fine. The workman, taking a bundle of flax in his hands, throws it on to the heckle, fixed to a stand before him, and drawing the flax through the teeth causes the long fibres to become parallel, whilst the short broken ones are retained by the teeth of the instrument; these latter are preserved and sold under the name of tow. In the flax mills, at the present time, this process is also performed by machines.

As thus prepared, either by the hand or by machinery, the flax is ready for spinning. At the present time nearly all the flax used in this country is machine-spun, some being made into yarn for the weaver's use, and a portion is employed in making linen thread, fit for lace-making and needle-work, by two yarn threads being tightly twisted together.

Flax, when woven, yields linen cloth, damask, sheetings, &c. At the present day most of these fabrics are made by the hand loom, as described in the introduction to this series of articles; the chief stations of the manufacture being Dundee, in Scotland, and the various parts of Ireland.

Hemp.—The plant yielding hemp is an annual, a native,

originally, of the warmer parts of Asia and Europe, but now much more extensively cultivated.

Its stem, which is erect and simple, or unbranched, is from four to six feet in height, and bears numerous leaves, supported on long stalks, and divided into five lance-shaped rough green leaflets, each of which is notched like a saw at the edge; the whole plant is covered with stiff hairs, giving it a peculiar harshness to the touch. The flowers are of two kinds, barren and fertile; they grow upon different plants, and are green and inconspicuous. Each fertile flower is succeeded by a small seed-like fruit, enclosed in the green cup of the flower; the fruit is collected and sold under the name of hemp seed.

These seeds (as we may term them, in accordance with custom) abound with oil, which they yield readily upon being crushed in an oil press. They are exceedingly nutritious, and are frequently given to birds in confinement. The oil obtained from them is much used in the preparation of varnishes; is sometimes employed in the formation of soft soap; and, occasionally, for burning in lamps.

The hemp plant, especially when grown in a tropical climate, possesses a peculiar narcotic power, and the leaves eaten, or even smoked, when dry, will produce intoxication. For this purpose they are much employed by the inhabitants of the East, to whom the use of wine is forbidden by the Mahometan religion; even the seeds, given in abundance to birds, tend to shorten their lives, and, in some instances, change the colour of their plumage to black.

Hemp is chiefly cultivated for its fibres, which are tough, flexible, and particularly strong; well adapted for the manufacture of coarse fabrics, such as sail-cloth, sacking, ropes, string, &c. So great is the demand for it for these purposes, that 600,000 hundredweights are yearly imported; chiefly from Russia.

For profitable cultivation hemp requires a sandy, rich soil. The plants, when full grown, are pulled up with the roots, the barren-flowered being first selected, whilst the fertile are left some weeks, in order that the seeds may ripen; the latter is readily rubbed out by hand. The roots and leaves are then removed, after which the stems are placed in water to rot, so that the fibres may be the more readily separated from each

other. The operation of rotting the hemp renders the water poisonous, and gives rise to offensive and pestilential odours; when it is concluded the hemp is beaten and heckled, like flax, and finally spun into yarn fit for the weaving of canvas, sack-cloth, sail-cloth, &c. &c. It is also used for the formation of string, cables, and ropes of every description. The length of each fibre of hemp being but between three and four feet, it is obvious that to make a string several fibres must be so twisted as to hold firmly together; this process is usually performed by hand. The spinner, taking a bundle of heckled hemp, wraps it round his waist, bringing the two ends to the front; he then draws out a few fibres, and, twisting them together, fastens them to a hook, which is twirled round with great rapidity by a strap passing over it from a large wheel, turned by a boy. The spinner now walks backwards, away from the hook, and as he does so the part twisted by the twirling hook draws more fibres out of the bundle round his waist, whilst with his hand he regulates their number, and so causes the yarn to be uniform in size.

Cord, or rope, is made by the twisting together a number of yarns. A small number are generally twisted together in the first instance, and several compound ones, so formed, re-twisted into a single cord.

Silk.—The process of the formation of raw silk has already been described, under the head of Silkworm Moth, page 103. We have now to trace its further progress into spun silk, adapted to the use of the weaver and sempstress. The hanks of raw silk are first washed in warm water, and then wound upon bobbins, or reels; this is accomplished by the winding machine, the effect produced by it being the same as when a skein of silk held on the outstretched hand of one person is wound upon a reel by a second. After being thus wound, the fine filaments of silk have to undergo the process of spinning, twisting, or throwing; this is effected by a very complicated engine, termed the spinning machine. For the stouter threads, required for some purposes, several of the threads thus obtained are again twisted together.

The thick, strong, and tightly-twisted silk, known as sewing-silk and twist, is made by hand, in the same manner that

hemp is spun into rope, each piece of silk twist being from fifty to one hundred feet in length.

The silk spun for the use of the weaver is usually dyed after it is twisted, being first boiled in soap and water to render it soft and glossy.

The only silk fabrics requiring a particular notice are shot silk, satin, and velvet.

Shot silk is formed by having the warp and the weft of different coloured threads, so that a play of colours is produced as the silk is seen from different points of view.

Satin owes its peculiar lustre and softness to the circumstance of its being so wove that the threads of the warp only are visible, the threads of the weft scarcely coming to the upper surface. This is accomplished by carrying each thread of the weft under five or six threads of the warp, and then over one; again under five or six, over one, and so on. By this means the weft threads are scarcely seen, and a rich, glossy, unbroken surface is produced.

Velvet, the soft pile of which is so peculiar, is formed by weaving short loops of silk into the fabric: these stand at right angles to, and hide both the weft and the warp; they are afterwards cut open by a sharp instrument, and the ends of the silk standing up from the cloth give to the velvet its peculiarly soft appearance.

The same kind of formation is readily observed in thick hearth-rugs, where the cut ends of short worsted threads rise up from a coarse canvas.

Wool.—From the earliest ages wool has been employed as a material for clothing. We are informed that Laban sheared the wool from the sheep during the life of the animals, as is practised at the present day.

When spun and woven, wool yields two distinct classes of products, woollen and worsted goods. The latter are spun, usually, from English wool, in which the fibres are long and coarse; they are subject to nearly the same process as cotton, and yield flannels, camlet, merinos, moreens, &c. &c.

Woollen goods, as they are termed, by which is meant the various kinds of broad cloth, kerseymere, &c. &c., are produced from Saxony and Australian wools, in which the fibres

are short; and peculiar processes are adopted to produce the soft nap distinguishing cloth.

The woollen manufacture, properly so called, is chiefly carried on in the west of England and Yorkshire. For this purpose the wool is first sorted into many different qualities, differing as to fineness, length of fibre, colour, &c. These various qualities are next separately washed in hot ley to remove the grease they naturally contain, after which they are generally dyed of the required colour. The next process consists in the separation of the various fibres one from the other, so that the wool shall be in the form of a light downy layer; this is accomplished by the locks of wool being torn apart by the sharp spikes of a machine; but before spinning they are required to be laid parallel; this process also, which in effect is somewhat similar to the heckling of flax, is, as well as the spinning into yarn, and the weaving, alike accomplished by machinery.

After weaving, the cloth is felted, or fulled, as it is termed. The fulling-mills are so constructed that the cloth is beaten with heavy oaken hammers for two or three days; this causes the fibres of the wool to lock together so as to hide both the weft and the warp. Cotton or linen goods could not be felted in this way, as the fibres are smooth; but each fibre of wool is covered with a series of rings of scales, like those of a serpent's skin. When woollen cloth is fulled, these scales hook into one another, and the close nap is the result. In a fibre an inch long there are about three hundred rings, or teeth. During the fulling, the cloth shrinks very much, both in length and breadth; cloth one hundred inches wide before fulling is about sixty inches afterwards; but in proportion as it shrinks in extent, it increases in thickness. The cloth, having been fulled, has the nap worked up or raised by rubbing it with teasel-heads; these are the flower heads of a plant, and are covered with small hooks, somewhat like what are called burrs by the children in the country; the hooks, seizing the nap, loosen and raise it up from the cloth; it is then cut of an even length, and pressed to give a glossy surface.

Worsted goods, made of the long-fibred, coarse English wool, are not fulled after weaving, and hence the fibres of the warp and weft are always visible.

At the present time every process of the manufacture of worsted goods is accomplished by machinery: the washing and drying of the wool; the combing and spinning of the fibres into the different kinds of yarn required for the various fabrics; and also its weaving when spun.

Worsted thread is formed in the same manner as cotton thread, by the re-spinning two or more simple yarns together.

NOTE.—For a fuller account of these manufactures the reader may consult the monthly supplement to the *Penny Magazine* for the last two or three years; or *Knight's Weekly Volume, Textile Manufactures,* in which these admirable articles have been republished.

LATELY PUBLISHED,

BY DARTON AND CLARK, HOLBORN HILL,

On a large sheet, with 60 Engravings, price 1*s*. 6*d*.; on canvas, rollers, and varnished, 5*s*.,

A TABULAR VIEW OF THE

CLASSIFICATION OF ORGANIZED BODIES.

AFTER CUVIER AND DECANDOLLE.

BY W. BERNHARDT TEGETMEIER.

"Admirably adapted for a ready comprehension of the divisions, orders, and classes of the animal and vegetable kingdoms. Pictorial types are given, which, with the easy reference to verbal and familiar explanations of the scientific nomenclature of natural history, and with the examples of the several groups, &c., cannot fail to interest, instruct, and encourage the inquirer. *We have seldom seen so clear and complete a tabular view.*"—*Literary Gazette.*

"The science of natural history has been so completely remodelled by the discoveries and exertions of the great naturalists above mentioned, and their systems have so entirely superseded those of Linnæus and others, and are now so firmly established, that some acquaintance with them may be considered as absolutely indispensable. The works, however, of the principal authors on this subject are too voluminous and scientific to attract the attention of beginners, or, indeed, of any but those who can devote a considerable portion of time to the pursuit of this most delightful branch of knowledge, and Mr. Tegetmeier has done the state good service in placing within the reach of all classes *an admirably arranged compendium and outline of the science in its modern state.* His tabular view contains within the compass of one sheet, and in a form calculated to render it an ornament to the library or parlour, a synopsis of the whole of the animal and vegetable kingdoms, as divided into vertebrate and invertebrate animals,—in the latter into flowering and flowerless plants. The classes and orders into which these grand divisions are distributed are distinctly shown—a slight but accurate and spirited outline cut of some animal as the type of each order—and the scientific and technical words and phrases are translated and carefully explained."—*Hertford Reformer.*

ADVERTISEMENT.